

THE TELEPHONE IN A CHANGING WORLD



THE TELEPHONE

in a Changing World

BY
MARION MAY DILTS



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THE TELEPHONE IN A CHANGING WORLD

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FIRST EDITION

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To
DEBBIE LYNN
on her first birthday



FOREWORD

WHEN VISITING THE UNITED STATES TWO YEARS AGO, SIR Richard Gregory, retired editor of the English scientific magazine, *Nature*, gave an address before a group of Bell Telephone Laboratories' members. I happened to be in the audience. The theme of Sir Richard's talk was the "gospel of science": "The highest purpose of scientific achievement," he said in effect, "is more abundant life for man. To discover a truth, to invent a machine or a method, may be gratifying and valuable, but the greatest achievement comes in putting the truth, the machine, the method, to use for humankind. The discovery of radium or vitamins, and methods for producing them, became truly significant when, by their use, cancers were healed and rachitic children were returned to radiant health. Maxwell's electromagnetic theory, confirmed by Hertz's experiments, came to fulfillment in radio broadcasting. And yet, as soon as these supreme achievements, the results of many years of tireless effort on the part of scientists and engineers, become a familiar part of our everyday life, they begin to lose their wonder. We forget their significance; we take them for granted and are not even curious about how they came to be."

Sir Richard quoted Emerson: "If the stars should appear one night in a thousand years, how would men believe and adore; and preserve for many generations the remembrance!" He said that scientists needed literary writers

to help "preserve . . . the remembrance." He was very inspiring.

I had been a member of the technical staff of the Bell Laboratories for several years before my marriage, and knew something of the telephone in this country. I had also used telephones and visited telephone exchanges and headquarters, incidentally, in many other countries, in the course of three trips abroad, to Europe, around the world, and to Japan. Still, I must confess that when I thought of the telephone it was usually in connection with my own convenience, rather than in its wider social relations. As Sir Richard spoke, however, I began to see the telephone in a different way, and I felt that I wanted to write the story of the telephone from the social point of view. Those with whom I discussed the idea were encouraging and this book is the result.

For the information which it contains, I am very much indebted not only to various members and departments of the American Telephone and Telegraph Company, the New York Telephone Company, the Western Electric Company and the Bell Telephone Laboratories, but also to the Information Department of the International Telephone and Telegraph Corporation, to the United States Independent Telephone Association, the General Telephone Corporation and the Automatic Electric Company. Various government agencies and other large users of telephone service also made valuable contributions through pamphlets and correspondence.

For most of the historic material in the chapter on Operators, I wish to express my gratitude for the use of letters received from early operators in answer to a questionnaire.

I also wish to express my appreciation to Mr. John W. Lea for his generous assistance and helpful criticism, to Mrs. Clarence Terpenning who typed the entire manuscript, and to my husband, Paul Kopp, who, among other things, bore the brunt of the proofreading.

MARION MAY DILTS

Jersey City, New Jersey

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THE TELEPHONE IN A CHANGING
WORLD

CHAPTER I

THE TELEPHONE IS INTRODUCED

PEOPLE HAVE PROBABLY ALWAYS BEEN FASCINATED BY THEIR voices, and the idea of a device enabling them to talk with others at a distance was naturally appealing. As early as 1854, a Frenchman named Bourseul published an article describing a method by which he believed speech could be transmitted electrically. Many inventors worked with the idea and many different claims have been made concerning the beginnings of the telephone. Mechanical "lovers' telephones" were devised from boxes or cans connected by a taut wire or string, which were said to carry private messages satisfactorily over distances as great as one hundred yards. Italians still celebrate the invention of an electrical telephone by one of their compatriots named Meucci who lived on Staten Island, New York.

The Deutsches Museum in Munich, Germany, presents the telephone as if it had been invented in 1860 by the German schoolmaster, Philipp Reis. A pupil of Reis', and an eyewitness of his early experiments, wrote in 1877: "The original telephone was of a most primitive nature. The transmitting instrument was a bung of a beer barrel hollowed out, and a cone formed in this way was closed with the skin of a German sausage, which did service as a membrane. To this was fixed with a drop of sealing wax, a little strip of platinum, corresponding to the hammer of the ear, which closed or opened the electric circuit.

The receiving instrument was a knitting needle surrounded with a coil of wire and placed on a violin to serve as a sounding board. It astonished every one quite as much as the more perfect instruments of Bell do now."¹ This instrument was greatly improved upon by Reis, and in later forms was exhibited to the Emperor of Austria, the King of Bavaria and distinguished scientific men.

Emile Berliner, a young immigrant serving as salesclerk in a Washington, D. C., dry goods store, in his off hours, with the aid of two physics books, patched up a telephone transmitter from a child's drum, a needle, a steel dress button and a guitar string.²

Elisha Gray, an American farm lad of scientific bent, who worked his way through Oberlin by developing apparatus for the college physics laboratory, in his mature years filed a caveat at the U. S. Patent Office for a telephone on which he was working. But it was Alexander Graham Bell³ who hit upon the idea of transmitting speech by causing an electric current to vary in intensity precisely as the air varies in density during the production of a sound.

Bell had not originally intended to invent a speaking device; like several other inventors in this country and Europe, he had been trying to devise a mechanism for sending a number of telegraph messages simultaneously over the same wire. In the course of his experiments, however, Bell was able to verify an idea he had, that the human voice might also be transmitted over wires, not by the making and breaking of a current as telegraph signals were, but by an ebb and flow in the strength of a continuous current, induced by means of sound waves. Though the men who were financing his harmonic telegraph ex-

periments, Mr. Hubbard and Mr. Sanders,⁴ at first failed to see how they were going to get any return on their investments from a voice-transmitting device, and tried to discourage his expenditures on it, Bell simply could not give it up. So confident was he in the success of his telephone, that he applied for a patent before completing a satisfactorily working model. On March 7, 1876, the patent was granted; and three nights later, in the attic of a boardinghouse at 5 Exeter Place, Boston, the telephone carried its first complete sentence of speech. Before this only single words or tones had been "telephoned."

It happened that Philadelphia was holding a great Centennial Exposition in that same year, to celebrate the hundredth anniversary of the signing of the Declaration of Independence; Bell decided to exhibit his new speaking telephone there. The uninteresting-looking device attracted little attention at first. The judges who were to inspect the exhibits were about to skip it, and betake themselves to more comfortable places for the remainder of a very hot Sunday afternoon.

Making the rounds with them, however, was a royal visitor, Dom Pedro II, Emperor of Brazil, who, because of his interest in schools for the deaf, had attended one of Mr. Bell's classes in Boston. Catching sight of the remarkable young teacher, Dom Pedro advanced to greet him—the judges politely followed and Bell was given an opportunity to demonstrate the working of his apparatus. "My God, it talks!" Dom Pedro is traditionally reported to have exclaimed.

Included among the judges was Sir William Thomson, the great British physicist, who had been knighted for his work in connection with the laying of the first successful

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transatlantic telegraph cable. Sir William had to make a report about the various exhibits which the judges thought worthy of awards, and this is what he wrote about the telephone:

Mr. Graham Bell exhibits apparatus by which he has achieved a result of transcendent scientific interest — the transmission of spoken words by electric currents through a telegraph wire. To obtain this result Mr. Bell perceived that he must produce a variation of strength of current in the telegraph wire, as nearly as may be, in exact proportion to the velocity of a particle of air moved by the sound; and he invented a method of doing so, a piece of iron attached to a membrane, and thus moved to and fro in the neighborhood of an electromagnet. The battery and wire of this electromagnet are in circuit with the telegraph wire and the wire of another electromagnet at the receiving station. . . I heard it speak distinctly several sentences, first of simple monosyllables, "To be or not to be" (marvellously distinct); afterwards, sentences from a newspaper, "S. S. Cox has arrived" (I failed to hear the "S. S. Cox" but the "has arrived" I heard with perfect distinctness) then . . . "The Americans of London have made arrangements to celebrate the Fourth of July." I need scarcely say that I was astonished and delighted, so were the others. We may confidently expect that Mr. Bell will give us the means of making voice and spoken words audible through the electric wire to an ear hundreds of miles distant.

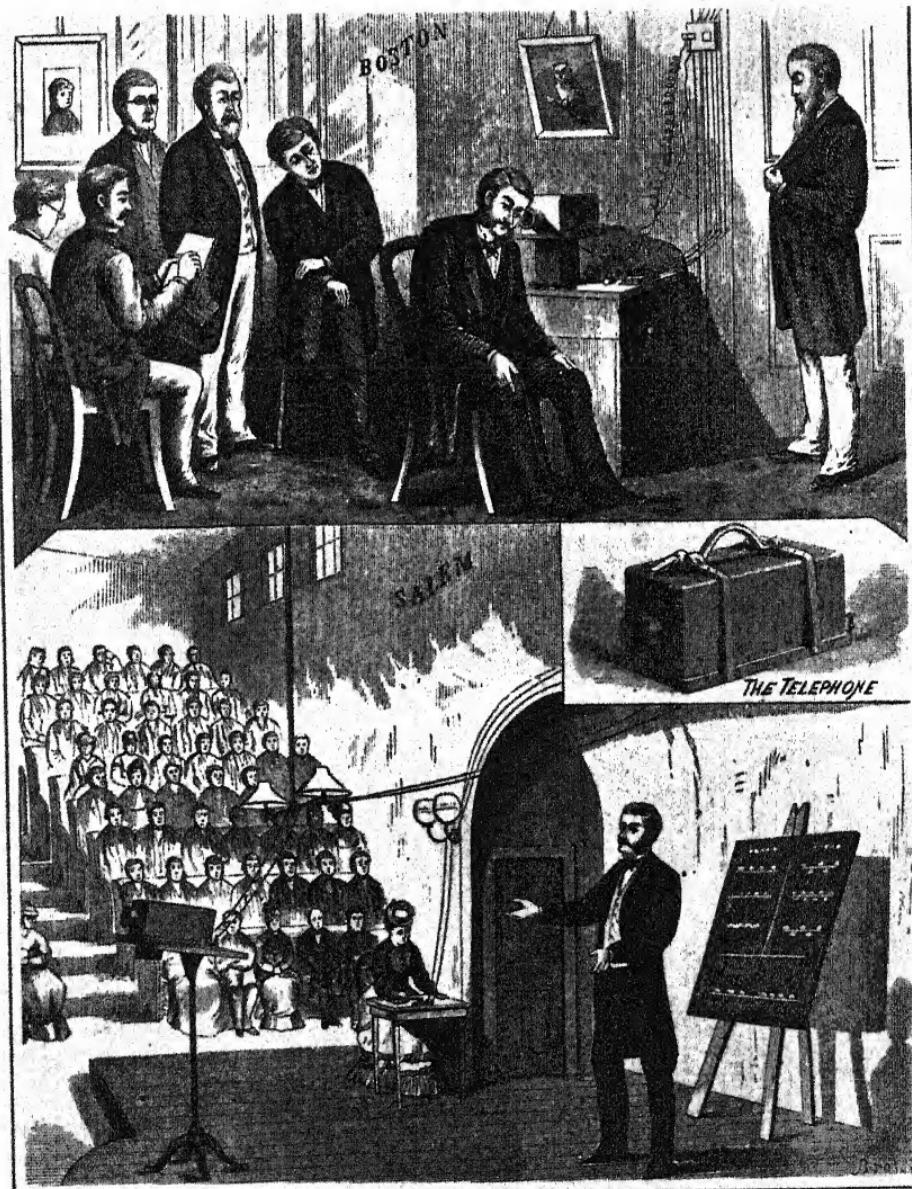
A young Japanese student attending one of Bell's classes in speech was also intensely interested in the remarkable invention of his teacher.

"Mr. Bell, will this thing talk Japanese?" he asked.

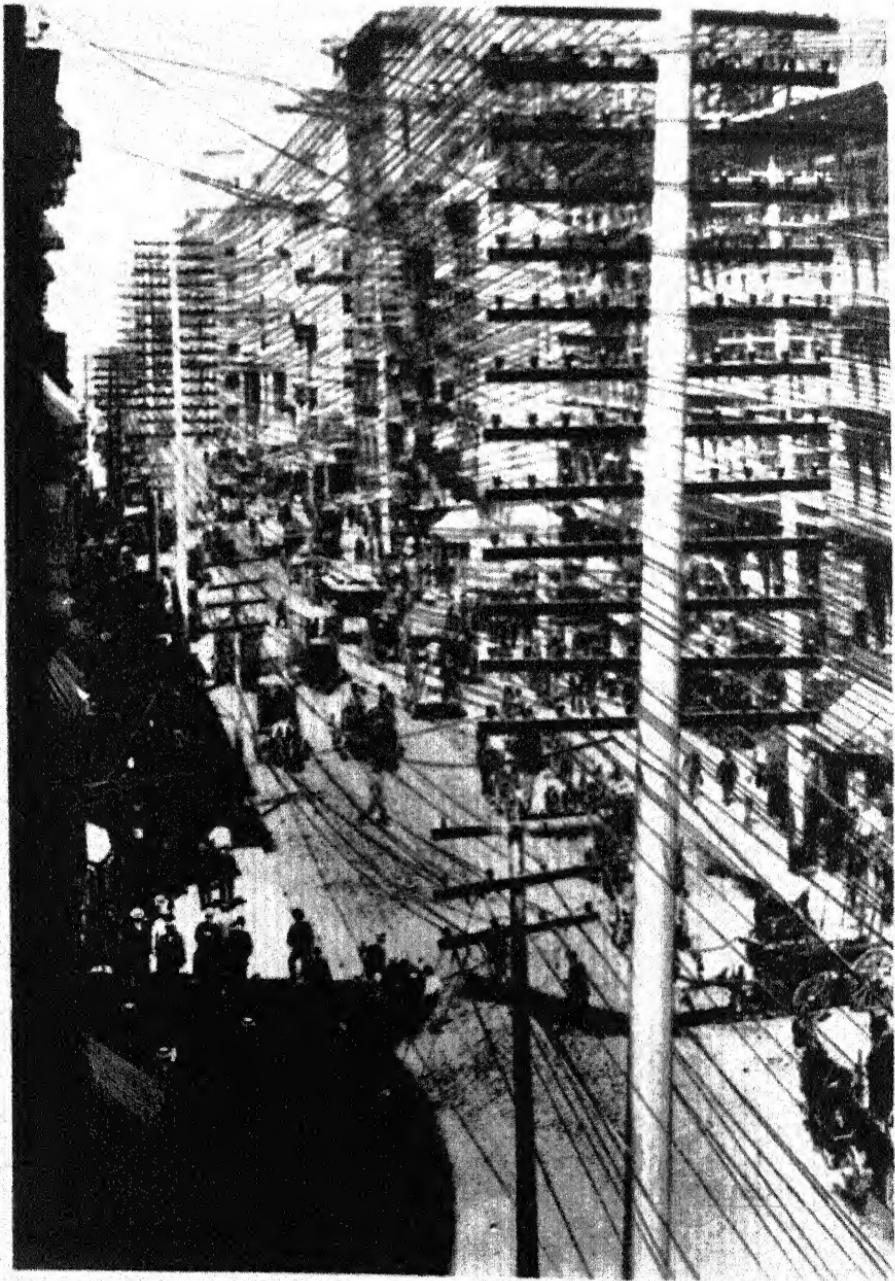
"Certainly," replied Bell, "it will transmit any language."

"May I bring my friends to try it?"

Bell agreed and this description of what happened "in one of those boardinghouses behind the State House" in



This Wood-cut, Reproduced from the SCIENTIFIC AMERICAN of March 31st, 1877, Shows Prof. Graham Bell Lecturing to an Audience at Salem, Mass. The Inventor is Illustrating His Demonstration by Means of a Telephone Placed Before His Audience and Communicating With His Laboratory at Boston, Fourteen Miles Away.



Lower Broadway in New York City in the 80s, showing overhead wires

Boston, in January, 1877, was written, years afterward, by the Japanese diplomat, Count Kaneko, who in his Harvard days had taken part in the first telephone conversation in a language other than English :

After explaining the discovery and invention of the telephone, he (Bell) took us into the next room—the same size as his bedroom. This room was used for his experimental purpose, where was a pile of coiled wires on one side, and on the opposite side, the same kind of wires was piled up, and two piles were connected by one line of wire. Pointing to these piles, he told that they are the same length of the submarine cable telegraph between New York and Liverpool.
(sic)

Giving me a receiver in one corner, he went to the other, and spoke with speaking tube in a very low voice, but I heard every word distinctly. Turning to me, he said : "There we speak across the Atlantic." Then he explained his project for organizing a telephone company in following plan—the following words are as nearly as he said at that time :

"In the center of Boston, we establish a main office, from which a separate wire is connected with the State House, the City Hall, hotels, banks, stores, factories, schools, newspaper offices, private residences and others. Then to show the usefulness : a person, waking up in the morning, calls up the main office and asks to connect with grocery store ; when connected, he tells to bring a bread, butter, fresh milk for breakfast at seven o'clock ; then again he calls up the main office to connect with the stable, and he tells to send a carriage to his house at eight ; and after then in the same way, he calls up his office boy and tells him to send a telephone to Mr. A. to come to his office at eight-thirty, and Mr. B. at nine, and Mr. C. at nine-thirty, to dispatch business. Is it not convenient ?"

Thereupon I asked Mr. Bell whether he consulted to organize a company with business men and capitalists. He said : "Yes ! but they will not take up my project ; therefore I am going to appeal to the public by a lecture, showing the wires,

machines, and the working process, and explain the usefulness."

A few weeks after, he gave a public lecture on the telephone in the Tremont Temple, Boston. I went and found a tolerably good audience. After the lecture, as we were going away, I overheard a group of men and women, in my front, saying: "Bell's invention is very ingenious and interesting, but to form a company and invest the money is another question."

Bell and his assistant, Watson,⁶ gave several demonstrations of the telephone, around Boston and New York, in theatres, hotels and fashionable clubs, hoping to arouse public enthusiasm for it, and to win some financial reward for themselves and their efforts.⁷ Audiences usually were greatly impressed with what seemed the almost weird and supernatural way in which speech, song and instrumental music came to them, and, quite as usually, were unable to imagine the device as being of any practical value; it was an interesting scientific toy, but certainly nothing that a prudent man would spend his money on.

Indeed, the telephone's operation in those days was often unintelligible and far from dependable. At one demonstration, held in Lawrence, Massachusetts, in May, 1877, the audience was able to hear practically nothing. This was satirized in the local paper⁸ by a lengthy poem containing the following stanzas:

To the great hall we strayed,
Fairly our fee we paid,
Seven hundred there delayed,
But where was Watson?

Was he out on his beer?
Walked he off on his ear?
Something was wrong, 'tis clear.
What was it, Watson?

Seven hundred souls were there
Waiting with stony stare
In that expectant air,
Waiting for Watson.

Doubtless 'tis very fine
When all along the line
Things work most superfine;
Doubtless 'tis, Watson.

Mr. and Mrs. John Q. Public were not accustomed in those days to a continual stream of new and wonderful conveniences issuing from industrial laboratories. They did not expect every scientific invention to be developed into something of commercial value. It is not at all strange that they failed to imagine what the telephone would come to mean in their daily lives.

Several men of scientific bent, however, at once became intensely interested in its possibilities and began to work on improvements for it: Professors Blake and Peirce, of Brown University; Professor Dolbear, of Tufts College; two Englishmen, a Professor Hughes, and a Reverend Hunnings; Berliner, a German-Jewish immigrant; Francis Blake, who was connected with the U. S. Geodetic Survey; the promising young inventor, Thomas Edison, and many others. Bell and Watson also continued to work together through the spring of '77 to put the telephone into better form for commercial use. A metal disk five inches in diameter replaced the original skin tympanum, and a bell-shaped mouthpiece was devised for concentrating the voice upon it. The original box telephone, with its single megaphone-like contraption for both speaking and listening, was replaced by a hand telephone, likewise without differentiated transmitter and receiver, the advantage of which lay in the

fact that you could wag it instead of your head, when you wanted your mouth and ear alternately to be in front of it. Other improvements were under way.

After the *Scientific American* published drawings showing the construction of Bell's hand telephone, scores of individuals and companies began to make telephones of similar design. One of these homemade phones was discovered in Vermont not so long ago. Its metallic diaphragm was an old daguerreotype still bearing the likeness of a couple of the finder's ancestors.

The first cash business in telephones was done in the spring of 1877, when a pair, one for each end of a wire, was rented for twenty dollars. Before this, however, a pair had been used by Charles Williams, manufacturer of telegraph instruments. It was in the attic of Williams' shop in Boston that Bell and Watson had first made the telephone mumble sounds, and it was in his shop that the first telephone instruments and switchboards were later manufactured. The first telephone line was strung from this shop to the owner's home in Somerville, a suburb three miles distant. Mr. E. T. Holmes, who ran a burglar-alarm business, having heard his friend's phones work, thought to introduce the new device to the bankers and businessmen of Boston, by connecting a few of them to some of his clients' wires during the daytime, when the alarm system was not in use. By means of an experimental switchboard, he connected these phones with one in his office. Four banks let the instruments stay, nailed up on their walls, but a fifth ordered "that play-toy" taken out.

The telephone then began to be advertised. The first broadside was issued by its promoters at Cambridge, Mass., in May, 1877. Soon several businessmen with imagination

were found ready to give the telephone a trial. A General Express Agency in Boston connected up some lines from various points in the city to their office and found the arrangement both profitable and convenient.

The enterprising proprietor of a drug store in Hartford, Connecticut, who had rigged up a buzzer system of communication between his store, a doctor's office and the livery stable where the doctor kept his horse, contracted for a telephone agency, and replaced his buzzers with a telephone system.

Other doctors were added to the system, and on August 17, 1877, the *Hartford Courant* reported:

At the regular meeting of the allopathic physicians on Monday evening, experiments were successfully tried with telephones, and it was proposed to have a system of intercommunication between the doctors established by means of the new invention, so that, by reporting to a central office at the Capital Avenue Drug Store, they can readily exchange news between office and office.

The value of the telephone in time of emergency and disaster was strikingly demonstrated from this drug store a few months later. News that a fearful accident had happened to an excursion train on the Shore Line was telegraphed to the Western Union Office in Hartford. The telegraph operator summoned the night clerk at the Capital Avenue Drug Store, who telephoned the twenty-one physicians on his line, and also ordered an express wagon from the livery stable, which he packed with bandages, morphine, chloroform and other supplies that he thought might be needed.

In the summer of 1877, the telephone was taken by Bell to England where he went on his honeymoon, good Scotch-

man that he was, aiming to combine business with pleasure. Sir William Thomson, who had been so "astonished and delighted" with Bell's exhibit at the Philadelphia Centennial, sponsored several demonstrations of the speaking telephone in the British Isles. The young inventor and his bride were presented to Queen Victoria and Bell arranged, in London, a telephone circuit over which Her Majesty might converse. When the Queen asked if she might buy two telephones, Bell made her a gift of a pair done in ivory, and a wire was soon strung to Windsor Castle. The Princess of Wales had her private apartments connected by telephone with her children's nurseries; the London *Daily News*, the Persian Ambassador and five or six other gentlemen also ordered telephones for their own use or amusement.

Bell was greatly encouraged by this, and enthusiastically prophesied to several London capitalists: "It is conceivable that cables of telephone wires could be laid under ground or suspended overhead, communicating by branch wires with private dwellings, country houses, shops, manufacturers, etc., uniting them through the main cable with a central office where the wires could be connected as desired, establishing direct communication between any two places in the city. Not only so, but I believe that in the future, wires will unite the head offices of the Telephone Company in different cities, and a man in one part of the country may communicate by word of mouth with another in a distant place."

This enthusiasm, however, was met with characteristic British conservatism. The attitude of most Britishers to the new invention was expressed by Sir William Preece, electrician of the government department which controlled

the telegraphs. Testifying before a special committee of the House of Commons, in 1879, Sir William said that he appreciated the beauty of the telephone as a scientific instrument, but "I fancy the descriptions we get of its use in America are a little exaggerated, though there are conditions in America which necessitate the use of such instruments more than here. Here we have a superabundance of messengers, errand boys and things of that kind. . . The absence of servants has compelled Americans to adopt communication systems for domestic purposes. Few have worked at the telephone much more than I have. I have one in my office, but more for show. If I want to send a message—I use a sounder or employ a boy to take it."

A demonstration of telephone communication was given in Japan to officials of the Department of Engineering and the Department of the Imperial Household, as early as 1877. Soon telephones were installed between various government departments and the palaces of the Imperial Household, and an attempt was made by a private company to promote the telephone commercially; but the government kept its monopoly on this as well as the telegraph, and it was not until 1889, that service was made available to the public.

Dom Pedro, having been the first head of any government to speak on the telephone, introduced it to the Empire of Brazil, in 1877, when he returned from his visit to the United States, but its use was not promoted.

In Germany, however, Bell's invention was making somewhat better progress. Bismarck had approved a system for connecting by telephone country post offices, which did not warrant the expense of special telegraph

operators and regular connection with the general telegraph system of the Empire. By the end of 1877, fifteen villages were thus connected, and within two years nearly eight hundred villages had, by this means, been brought into communication with slightly bigger and busier neighboring towns.

In France, also, telephone experiments were being carried on by the government. Telephones "roughly made in dockyard workshops" carried bugle calls over three miles of cable, affording "another proof of the small amount of accuracy required for successful working of these instruments." Telephones constructed on the Bell model were also "to be had at M. C. Roosevelt's, Mr. Bell's agent in Paris; the model in greatest request is the great square one with a horseshoe magnet enclosed in a flat box with a horn on its upper side which serves as a mouthpiece. This system has been neatly constructed at Boston under the best conditions. The sounds thus produced are much stronger and more distinct."

The sounds of the telephone were indeed growing much stronger and more distinct in Boston, for during Bell's year in Europe his loyal friends, Watson, Hubbard and Sanders, had been devoting all their energies and resources toward its development. Watson, himself, had devised many improvements in telephone operation and superintended the manufacture of the necessary apparatus and equipment, working day and night to fill the orders which came in. Mr. Sanders saw the entire fortune he had built up by his leather business disappearing into wire, rent, and wages for making telephones. Mr. Hubbard always carried a pair of telephones in his suitcase, on his travels as head of a postal transportation commission — carried them all the way to

California demonstrating and explaining the wonders of his son-in-law's invention to any and all who would listen, delightedly granting to young men who asked for it the right to lease and operate telephones in Boston, Chicago, Philadelphia and New York. In the first two months of his efforts, eight hundred or more phones were leased at ten dollars a year; in six months the number jumped to three thousand.

Businessmen seemed somewhat inclined to have the novel devices installed in their establishments, because they could advertise the fact in the papers and people would say, "Oh, did you see So-and-So has one of those new telephones in his shop? Let's go have a look at it." But they were still slow to imagine its future possibilities and could not be persuaded to invest any money in the infant enterprise. When Hubbard approached the spectacular railroad magnate, Chauncey M. Depew, with the proposition that he invest ten thousand dollars in the telephone business, in return for one-sixth interest in it, the latter followed the advice of his friend Orton of the Western Union and declined to risk the money. Bell's invention was still far from being distinctly articulate or dependable in operation. It seemed reasonable to believe that when better communication facilities were available, Western Union would offer them.

As a matter of fact, by the summer of 1877, the Western Union was beginning to feel that the telephone might be developed into something important. A year before, it had refused Hubbard's offer to sell Bell's invention for one hundred thousand dollars, asking "What use could this company make of an electrical toy?" but, in the fall of '77, it acquired through a subsidiary, The Gold and Stock

Telegraph Company, the rights to Professor Dolbear's telephone patents when, as, and if, they were granted. Three months later, Western Union organized the American Speaking Telephone Company with the right to use the pending patent of Elisha Gray; and the following spring, it obtained control of a telephone transmitter developed by Thomas Edison, which was far superior to any the Bell people had been able to produce thus far.

All this had been going on while Bell and his bride were in England and, by the time they returned to America, the Western Union had begun to lease phones and establish exchanges in competition with the Bell licensees. Already there were several thousand "hand" and "box" telephones, in use in local communities all over the United States from New England to San Francisco, with Western Union ones abounding especially in the Middle West.

New Haven, Connecticut, became the first city in the world to have a commercial telephone exchange, when a switchboard with eight lines and twenty-one telephones was placed in service there, in January, 1878. New York's first central office, not in New York City, but in the capital, Albany, was opened two months later, with the unexpected total of fifty subscribers. This large number proved to be a not unmixed blessing, for while it had been expected to limit the number of subscribers on a line to ten, it became necessary to put on as many as twenty, and the results were not always pleasant to listen to.

Nearly every problem was a new one to telephone company managers and, because of their limited knowledge, doubly perplexing. An amusing story is told of a manager, with practically no electrical knowledge, who nevertheless refused to be daunted. When a leading citizen burst into

the office indignantly demanding that his telephone be removed, the manager went with him at once. After manipulating a few screws, he announced that the instrument would now work all right. "The gudge," he explained, "was doubtless too close to the binding post, which interfered with the diaphragm, and that caused a reflex action in the circuit, creating residuary magnetism in the permanent coil." Mollified by this prompt, if somewhat incomprehensible, explanation of his troubles, the subscriber exclaimed, "Thank God, someone knows something about it. Let it stay."

For the benefit of its subscribers, the New York Telephone Company published the following directions:

After speaking, transfer the telephone from the mouth to the ear very promptly. When replying to a communication from another, do not speak too promptly, give your correspondent time to transfer, as much trouble ensues from both parties speaking at the same time. When you are not speaking, you should be listening.

Subscribers should bear in mind that on a telephone line they are within the possible hearing of a number of ladies and gentlemen. We ask all to be courteous.

If a thunderstorm threatens, insert the metal plug that is supplied with the bell, in the hole between the two plates of the lightning arrester.

Some of the early telephone advertising read like this:

Oh! no, the Telephone wires are not hollow; the voice is transmitted by waves of electricity. Telephones are rented only to persons of good breeding and refinement. A householder becomes morally responsible for its proper use by all the members of his family. There is nothing to be feared from your conversation being overheard. Our subscribers are too well bred to listen to other people's business.

Early in 1878, to lighten the financial burden on their friend Sanders, who had already sunk well over a hundred thousand dollars in the telephone, and to make possible further development of the business, a number of prominent Massachusetts and Rhode Island businessmen formed the New England Telephone Company with capital of \$200,000. A few months later, for the extension of telephone facilities outside of New England, the Bell Telephone Company was formed, with a young railroad mail superintendent, named Theodore Vail, whom Mr. Hubbard knew to be very able, as general manager, organizer and promoter. It was capitalized at \$450,000.

The Western Union, however, had almost ten times as much capital, and was so well established with its host of agents, network of already strung wires, ^{at} claim upon all newspapers, hotels, railroads and rights of way, and strong political influence, that these newly organized companies at first seemed to be in a hopeless position. "Uncle Joe" Cannon, then a young member of Congress, was sorry that the telephone backers had "got hold of a nice fellow like Vail," and the Assistant Postmaster General could scarcely believe that a man of Vail's sound judgment, "one who holds an honorable and far more responsible position than any man under the Postmaster General, should throw it up for a d—d old Yankee notion (a piece of wire with two Texan steer horns attached to the ends, with an arrangement to make the concern bleat like a calf) called a telephone."¹⁰

But that same year, Emile Berliner, improving on the work of Francis Blake, succeeded in producing for the Bell Company a transmitter fully equal, or superior in quality of operation, to the one devised by Edison and used by the

Western Union. And an instrument was also made available to Bell subscribers, which had transmitter and receiver separate, so that a person did not have to be a sleight-of-hand performer in order to carry on a moderately brisk conversation.

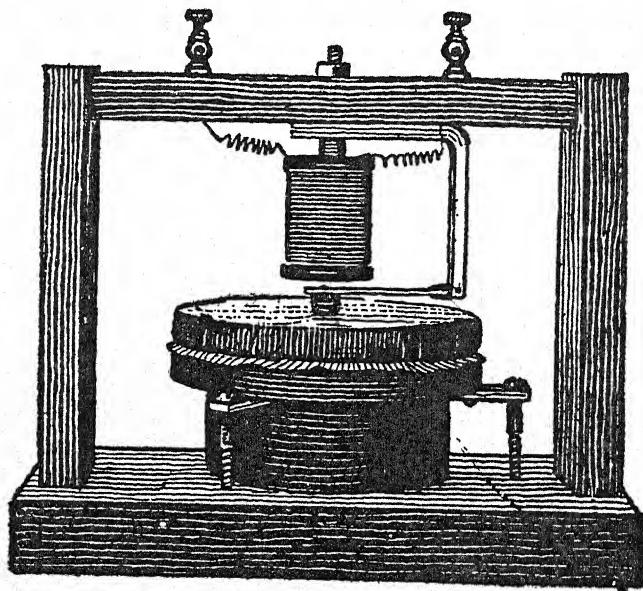
More and more people were coming to experience the satisfaction of being able to speak directly by telephone with someone whom they wished to reach. With its new improvements, it was much pleasanter to use than telegraph blanks, and gradually people were coming to believe that someday the telephone might be developed into a really successful enterprise.

In the spring of '79, with the continued cooperation of Hubbard and Sanders, the New England and the Bell Company amalgamated to form the National Bell Telephone Company. Vail had mapped out telephone service for the whole country and appointed authorized agents to undertake the construction of necessary lines and the leasing of apparatus. He had also licensed five manufacturers of electrical equipment in Baltimore, Boston, Chicago, Cincinnati and Indianapolis to manufacture telephone apparatus.

The following November, the Bell Company's suit against the Western Union for infringement of its patents, before a court decision was reached, resulted in the latter company agreeing to sell all its telephones and telephone systems (some 56,000 phones in 55 cities) and retire from the public telephone business.¹¹ Telephone stock rose to \$350 per share.

At about the same time John D. Rockefeller had taken in his competitors and obtained control of all phases of the oil business on behalf of the Standard Oil Company. These

were the days when big businesses began to grow up in the United States and the telephone, which less than four years before had uttered its first sentence, already gave promise of becoming one of them. Further than that, Mr. Hubbard organized the International Bell Telephone Company and went to Europe to promote its interests there.



The First Bell Telephone

CHAPTER II

WHAT AMERICANS DID WITH THE TELEPHONE

Most Americans of the late 'seventies were not thinking very much about their communication facilities. They had become so accustomed to the telegraph that, if they remembered its first days at all, they smiled at recalling their naïve enthusiasm for it. It was thirty years since James Gordon Bennett of the *New York Herald* had amazed his readers by having Keynoter Henry Clay's entire speech to the 1848 Whig Party Convention rushed from Lexington, Kentucky, to Cincinnati by fast horses, and telegraphed all the way from this Ohio city to New York. They laughed as they remembered that, in those days, some scientific men had thought there was a definite connection between the working of the new telegraph lines and a cholera epidemic.

Twenty years had elapsed since President Buchanan and Queen Victoria exchanged congratulatory messages via Cyrus Field's Atlantic Cable. It was amusing to recall that the papers had then predicted:

Tomorrow the hearts of the civilized world will beat in a single pulse, and from that time forth forevermore the continental divisions of the earth will, in a measure, lose those conditions of time and distance which now mark their relations, and that Longfellow had written in his diary for August 6, 1858:

Go to town with the boys. Flags flying, bells ringing to celebrate laying of the telegraph.

Some lesser poet, waxing lyrical, had written of the telegraph:

Lo the golden age is come !
Light has broken o'er the world.
Let the cannon-mouth be dumb,
Let the battle-flag be furled ;
God hath sent me to the nations
To unite them, that each man
Of all future generations
May be cosmopolitan.¹

In 1861, it became possible to telegraph all the way across the continent from New York to San Francisco, but the Civil War continued anyway. Eight years later, when the Union Pacific completed the first transcontinental railroad, the driving of the gold and silver spikes in the last tie were telegraphed all over the country.

Large cities had messenger services, like the American District Telegraph Company, which leased to subscribers, for two or three dollars a month, a cranking device for calling an authorized boy to do almost any kind of errand. After a good night's rest, the street car horses whisked along at better than four miles an hour. In New York City, an inventor had been experimenting with a car run back and forth by means of compressed air in a tunnel under the street, but nothing had come of it yet.²

The telegraph supplied the needs of the railroads and of the newspapers, politicians and big-business men for rapid communication. Ordinary folk did not very often have occasion to communicate at a distance in those days. Our population was only about one third of what it is now, and seventeen postage stamps a year fulfilled the communication requirements of the average person. Most men and

women lived their lives, visited and died, within fifty miles of the place where they were born. When they wanted to know how John and Mary were doing, they hitched up and drove over in the buggy, or inquired at the general store when they went there for the mail. They sent telegrams only when something momentous happened; the receipt of one was cause for anxiety.

Communities were small and self-sufficient, producing what they required for their own needs. There was no exchange of Florida or California fruits and Maine potatoes. There were no mail-order houses. Manufacturing, for the most part, was carried on locally by hand labor in cramped shops; huge factories did not exist. Since structural steel and electric elevators had not yet joined the telephone in the trinity that made skyscrapers possible, few buildings were over four stories high.

The United States was having a depression when the telephone was invented. As an aftermath of the Civil War and overexpansion of the railroads, banks and businesses all over the country were collapsing. The East was left badly off by the too rapid settlement of the public lands in the West. Strikes and financial panics were commonplace. To sell even everyday necessities was a difficult job.

People who attended the lecture demonstrations of the astonishing new instrument which carried human voices over several miles of wire, found them highly entertaining; but men were embarrassed as well as delighted when invited to speak into it, because after all it was just a toy; they did not think of it as the coming means of communication. It was the sort of thing that boys, fond of tinkering, found their fathers pleased to help them with and popular magazines published directions for making in home

workshops. *The Youth's Companion* offered a telephone as a premium for a new subscription, and almost anyone felt qualified to make improvements in the new invention.

The magazines of the day published many suggestions. The English scientific periodical, *Nature*, suggested that a tuning fork be introduced at the sending station to be bowed with a fiddle bow when conversation was to start. When the call bell was introduced, *Leslie's Illustrated Magazine* had a feature article about it. The report of telephonic chambers with small glass windows and caoutchouc-lined doors having been devised in Spain to isolate the user from external noises which might prevent his hearing the "fairylike faraway whisper" of the telephone receiver, elicited the criticism that this was really too elaborate; that all that was needed was a fixture to envelop the instrument and the head of the speaker, something like the top of a diving suit.

A crop of telephone jokes and cartoons also appeared. These usually dealt with a telephone user who was both surprised and angered to find his telephone speaking some language other than his own, or with a servant who, wishing to save his employer any inconvenience, cut the telephone cord, when the bell rang, and carried the instrument to where the employer was. Someone said that the manufacturers of jew's-harps were sadly concerned about their business since telephones were being promoted. The *Chicago Journal*, early in 1878, irreverently suggested:

Now that the telephone makes it possible for sounds to be canned the same as beef or milk, missionary sermons can be bottled and sent to the South Sea Islands, ready for the table, instead of the missionary himself.

A sermon by Henry Ward Beecher, the highest paid pulpit orator in the country, was, as a matter of fact, not exactly bottled, but telephoned, together with the rest of a Sunday morning service, through a transmitter under the pulpit of the Plymouth Church in Brooklyn, New York, to specially set up receivers in churches in Newark and Elizabeth, New Jersey.

Though telephone promoters were willing to make the most of all forms of publicity, they soon made it obvious that the telephone was neither a toy nor a joke. They intended that it should become another outward and visible sign of American foresight and passion for progress. They were determined that the telephone should help accomplish the colossal task of transforming three million square miles of comparatively undeveloped country into a closely integrated and flourishing United States. They wanted to help make, of fifty million scattered settlers, a united American people.

Then serious-minded social leaders began to decry these efforts. "Telephones," they said, "will throw the messengers and errand boys out of their jobs! And what will all the poor widowed mothers do then?" they asked the public.

Outspoken businessmen prophesied loudly, "You'll never get a switching center here, young man. Why everybody knows how a little summer thundershower shook the board so all the signals dropped at Salt Pond! That scientific toy won't come to anything. You're just wasting your time on it."

By 1881, however, the telephone promoters were able to report that "only nine cities of more than ten thousand inhabitants in the United States and one of more than fif-

teen thousand were without a telephone exchange" . . . and . . . "the business of connecting cities and towns by telephone wires has been taken up in the past year with some vigor. . . Boston is now in communication with seventy-five cities and towns including Providence, Worcester, Springfield, Lowell, etc. . . It will take some time yet to get first-rate service in a large network of towns, but only experience and tests of various methods are needed to reach satisfactory results."

In the year 1885, only ten years after the telephone was invented, the American Telephone and Telegraph Company was chartered for the purpose of providing long distance service in the United States. Specifically its charter read: "to connect one or more points in each and every city, town, or place in the State of New York with one or more points in each and every other city, town, or place in said State and in each and every other of the United States and in Canada and Mexico; and each and every of said cities, towns, and places is to be connected with each and every other city, town, and place in said states and countries, and also by cable and other appropriate means with the rest of the known world." A rather ambitious program!

Progress was being made, though, on a sound scientific basis. At first, the telephone had had to depend for improvements upon professors of physics and chemistry, upon shops selling "philosophical apparatus for experimentation" and upon the manufacturers of telegraphic equipment. But Stevens Institute and Cornell University had begun to offer courses in electrical engineering, in 1884. Specialists in telephone engineering were gradually developing, who realized that there were essential differences between the

telephone and telegraph. Previously, attempts had been made to adapt for telephone purposes the telegraph type of switchboard and the heavy iron wires strung on poles and frames, which carried the intermittent and relatively strong current of the telegraph. The telephone, however, required only the most delicate current, a minute fraction of the power necessary to operate a vest-pocket flashlight was sufficient for its operation. Apparatus and equipment suited to the peculiar needs of the telephone were beginning to appear.

Then a change began taking place, also, in the attitude of the public. It was illustrated in the following quotation from "The Prophet's Column" of the *Electrical Review* in 1891:

The man who could have bought telephone stock at \$10 a share and didn't is now becoming extinct. He was wont to repeat the oft-told tale of the grocer who did and got it in payment of a bad debt at that. In his place we have another specimen quite as easy to recognize. After some of the strange tales of electrical science have been discussed, he is sure to gravely remark, as though it had never been uttered before, "Well, electricity is in its infancy" and quickly add the inevitable corollary, "but it's the coming power, though."

Just watch this man. You will be surprised to see how many there are of him. He is the Public. The marvelous products of electrical science have so charmed his mind that no story of its newly discovered powers can be so much at variance with the laws of nature as not to be received by him with ready belief.

Merchants and salesmen were changing their business methods. Jobbers no longer had to have their shops close to the wholesale dealers. Trade in perishable items became less precarious. Country merchants began to order goods

by phone instead of going to the city. In this way they were able to replenish their shelves more frequently, and spare themselves the expense of carrying large stocks. Traveling salesmen from the cities were beginning to pick out "key towns," from which to telephone to their customers in the surrounding towns, instead of visiting them all in person. With the advent of the telephone, many industries whose success depended upon a quick and ready knowledge of market conditions also improved greatly. It was possible to make sales and deliveries much more promptly and profitably. Every kind of enterprise could now speed up.

In large cities, the demand for business telephones increased rapidly and, as a result, created several serious problems. A seeming jungle of poles and wires grew up on busy streets, at intersections and around large buildings. Severe sleet storms in winter repeatedly wrought havoc with these, endangering both buildings and pedestrians. Thaws invariably sent down chilly showers upon unsuspecting passers-by. It was almost impossible to photograph public buildings. Firemen could not put up their ladders without cutting telephones wires.

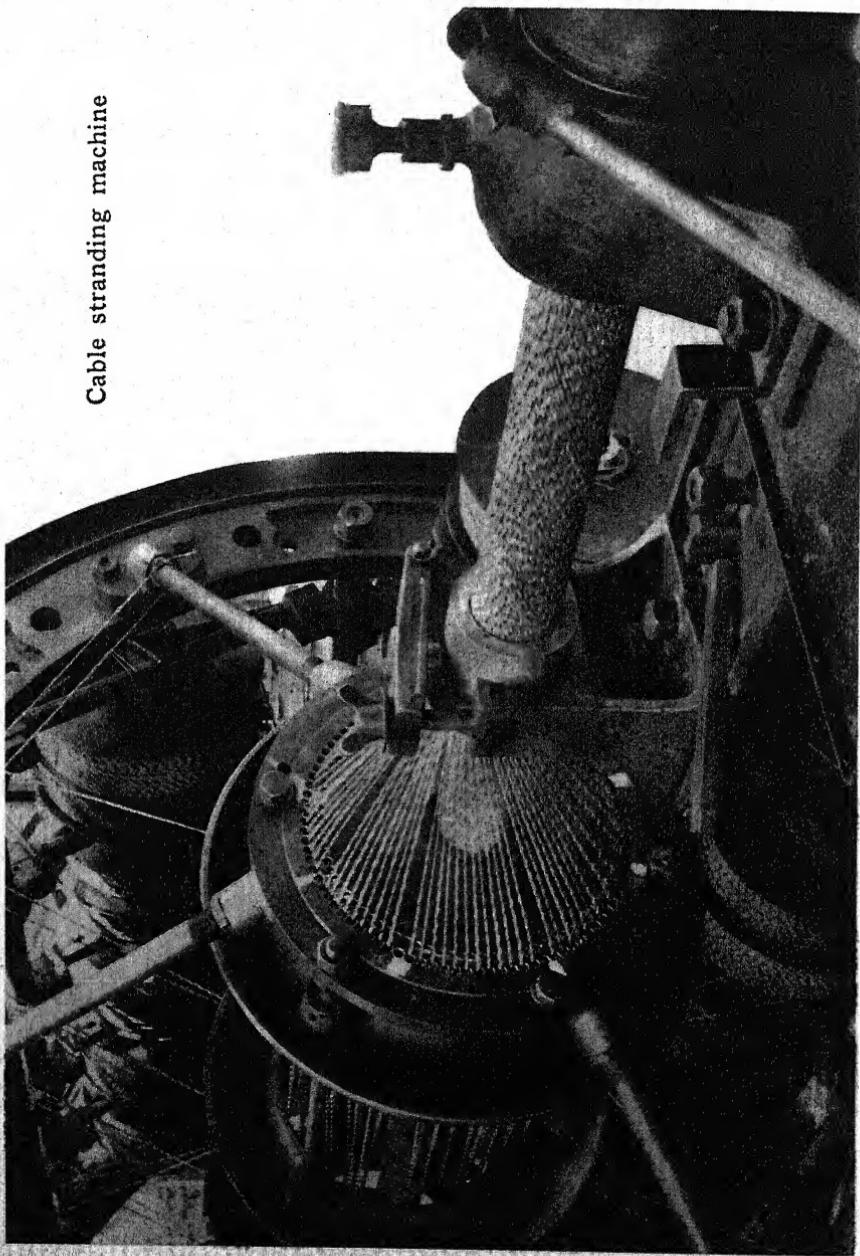
In stretches of open country, especially in the West, newly strung strands of shiny copper were attractive targets for marksmen to shoot at, and Indians thought it pretty stuff for personal adornment.

It seemed almost necessary to devise some system for putting telephone lines underground. In New York City, as a matter of fact, strong official pressure to the point of sending out crews of axmen to chop down the poles was brought, in the late 'eighties and early 'nineties, to make the telephone companies do this.



Cable splicers in a man hole

Cable stranding machine



How to plan an underground system for a rapidly growing city like New York, however, was an almost staggering problem. Cables, made up of several wires, were in only a primitive stage of development and clay conduit was as yet unheard of.

Telephone men made their first attempt to lay a long stretch of cable underground on Sunday. For convenience, they wanted to do it by plowing a furrow along the railroad tracks between Attleboro, Massachusetts and Mansfield, seven miles distant; on Sunday there were few enough trains to permit their operations. But where could the New England farmer be found with religious principles lax enough to allow his plow to be worked on the Sabbath day? When finally a plow was hired, it was attached to a locomotive and a trench was quickly dug. In the trench, several sections of many possible types of wire were laid in leaden pipes and spliced, where necessary, in watertight boxes. After the whole was covered over again, and connected by telephones, it was, unhappily, found that voices faded almost beyond hearing in traveling this underground circuit.

The devising of satisfactory cables became a major problem. Cotton-wrapped, oil-soaked and eventually paper-taped, dry-core cables came into being in many sizes; some consisting of a few thick wires were so heavy that a giant truck and eight teams of horses were required to haul them into place. To supply the busiest parts of large cities with adequate service, however, since the complicated underground networks of subways, pipes and tunnels made it almost impossible to add more ducts for telephone cables, new cables had to be made capable of carrying more and more messages in less and less space. Single sheaths which

contained as many as four thousand tiny wires without being unwieldy, eventually were devised.

As the telephone business continued to grow in large cities, switchboards also became more and more complicated; the cost of adding new subscribers seemed to rise not in direct, but in almost geometric ratio to their number. Some multiple boards cost as much as a third of a million dollars.³ When he considered the difficulty in getting them to work and the probability of even greater complications and expenses in future, the General Manager of one telephone company used to say, that so far as he could see, all he had to do was get enough subscribers and the company would go broke. And yet for the cheapest service in those days, the subscriber paid about a hundred and fifty dollars a year!

Not infrequently, in the early days, it happened that connections were broken, or service interrupted, in the midst of business deals that meant big money to telephone users. Then the telephone companies, although they did not guarantee perfect service, often found the irate victims of such circumstances threatening to sue them.

A Kansas City undertaker, named Strowger, was one of these disgruntled customers. He had an idea, so the story is told,⁴ that his local operator was conspiring with one of his competitors to ruin his business by falsely reporting his line "busy." The plot did not really exist, but Strowger rigged up a device to prevent such a thing from happening. Proudly he exhibited his model "telephone machine," made from a circular collar box, to a young salesman from Chicago. The salesman, sometime later, went into a central office to make a call, and found the operator chatting with

a friend. A shutter dropped in the switchboard indicating that someone wanted her attention. "That's only old Mrs. Jones," the operator said, and went right on with her social conversation. Thereupon the salesman, according to the story, determined to push Strowger's invention until it was perfected into an automatic exchange. The first one of these was put into operation at La Porte, Indiana, in 1892.

A ten-line automatic system had been designed at the Vatican, and in use there, several years before this. And forty subscribers in Wichita Falls, Texas, had installed a cooperative system in which each subscriber made his own connection with any other, by keyholes in a box connected with his phone. A contemporary press account of this installation stated: "The citizens of Wichita Falls are proud of this modern system, as it is said to be giving them excellent service." It was not until many years later, however, that the dial system, which we know, was developed.

At first, in small communities, the only telephone in town might be the public telephone in drug store or railroad depot, where druggist or stationmaster acted as the company's agent. Hotel clerk or storekeeper placed the call, ushered the patron into a booth, timed the connection and collected the money. At the Grand Central Terminal in New York, permission to install a single public telephone was granted (apparently with some doubt) in 1889, and it became the responsibility of the manager of the Bureau of Information.

The first public telephones undoubtedly did much to advertise the service.⁵ A widely used style of early telephone booth in keeping with the elegance of contemporary hotels had silk-curtained windows with tiny panes and

opaque colored glass in the door. Hotel guests sometimes mistook them for elevators.

Pay telephones also were introduced in the 'eighties. The usual principle on which these worked was that the deposit of a coin unlocked something, perhaps the crank with which the user signalled the operator, or a sliding door in front of the mouthpiece. Sometimes the entire telephone was enclosed in a locked box for which a coin served as key. One inventor reversed the usual order and located the telephone in a booth having a door which locked behind the user when he stepped inside. After he had made his call, the user could escape only by depositing a coin in the door lock. Few of these early devices had any mechanical means of giving the customer back his money, if a call could not be completed. One attempt to remedy this difficulty relied on nothing more or less than a piece of string.

One telephone to a subscriber was the custom in those days; not even government officials had extensions on their desks. In 1881, the Department of State, for example, had only a single phone in its whole building, and this was in a room adjoining the Chief Clerk's office. One day when it rang, the man who answered it hurried to the Chief Clerk to say he believed the White House was attempting to tell them that President Garfield had been shot. By 1895, there were still only two telephones in the Department, one in the outer office of the Secretary of State, and one in the corridor for the use of all other officials and employees.⁶ In the White House there was only one phone, and President Cleveland answered it himself when the clerks were not on duty. Wide publicity was given the fact that President McKinley was notified by long-dis-

tance telephone all the way from Chicago of Admiral Dewey's victory over the Spanish fleet in Manila Bay.

At the end of 1892, there were about ten thousand telephone employees and almost two hundred and forty thousand telephones in the United States. Bell Companies had established their exchanges and leased their phones in all of the large cities, but they had skipped the rural districts, where the cost of construction seemed to be out of reasonable proportion to the quantity of business. Other companies looked forward to January 30, 1894, when the original Bell patents would have expired. Since the Bell Company paid annual dividends of \$18 per share from 1889-93 the telephone business was thought of as a bonanza.

Owing to the business depression there is much unemployed capital, and many idle factories [wrote *The Western Electrician* editorially]. Many manufacturers will be eager to utilize their plants in the production of telephones, once the patent restriction is removed. . . We are on the eve of an era of active production of cheap telephones and of a healthy competition.

Within the next few years about six thousand independent telephone companies started up throughout the country, especially in small towns, villages and farming districts. Some were formed by passing the hat to merchants, doctors, lawyers and livery stable men. Any kind of equipment was bought up and connected. Many small places had automatic switchboards so that operators were not necessary. Barbed-wire fences were sometimes used as telephone lines (but they didn't work when it rained). The Chinese merchants in San Francisco returned their phones to the Bell Company because "too much chargee" and

bought up secondhand apparatus to connect over the roofs of Chinatown.

The Bell Companies cut their charges—so did the Independents. A great “rate war” ensued, attended by much publicity. Newspaper advertisements and editorial comment implied that businessmen without telephones were too far behind the times to merit patronage; businessmen with telephones were plied with folders of suggestions for using them to increase sales. Message rates, pay stations, party lines, private branch exchanges were introduced.

The new and biggest appeal, however, was directed to the farmers. A piece of broken farm machinery need not mean a trip to town and a wasted day for the team if you have a telephone! Give your family the protection of the telephone in case of sickness, fire or other accident! Preserve old family ties, prevent loneliness; have a telephone installed. A telephone will save time for yourself and wife in your busy season! Get the latest information on markets and the weather; a telephone will save you money!

Farm papers gave directions for building a small telephone system; forming a local cooperative telephone company; buying phones at two-fifty each and maintaining them at one dollar a year. Granges introduced telephones in some places. At first, local service was sufficient, then more and more “Long Distance” was called.

The Drover's Journal, published in Nebraska, printed the statement: “No modern invention has so thoroughly revolutionized rural communities, as the telephone.” When mail carriers could not get through local editors read the news over the telephone. “Discussion periods” were also held. Neighbors living miles apart shared “sings” and tal-

ent of various kinds over the telephone; fiddle music was the most popular. Listeners commented after each number and requested selections. Occasionally a subscriber owning a phonograph played recordings, and announced the title of his record. Thus, request programs, announcers and "canned music" were introduced on rural telephone lines, long before the advent of radio broadcasting.

Grain brokers, and meat packers could no longer cheat the farmer or rancher by having their "street buyers" in grain or livestock counties meet him on the way to town and get his load before he was able to find out what current market prices were; he had listened to the market report, over the telephone, before deciding to come to town. Western farmers became telephone conscious first; Southern ones last. When President Theodore Roosevelt tried to improve the condition of farmers, many people advised him to get them using telephones.

Not only those who worked on the soil, but also those who worked under it, found that the telephone made a great difference in their daily lives. Very early in their development, telephones were installed in mines, where they not only speeded up operation, but also greatly increased the safety of miners, and their chances of rescue when accidents occurred.⁷

As telephone business expanded, the keen and often bitter rivalry between the Independents and the Bell Companies continued down to about 1910. It had become increasingly obvious, however, that though this rivalry had had the effect of lowering rates somewhat in the beginning, in the long run it was neither efficient, economical nor satisfactory to have two telephone systems operating in one

town. It meant not only useless duplication of expensive equipment for the operating companies, but also great inconvenience for subscribers, who frequently had to subscribe to both systems and look through two directories to find the number they wished to call. As long-distance telephony developed, the independent companies, operating only locally, found themselves more and more at a disadvantage. Many of them had to sell out to the larger company. Along about 1910, anti-trust agitation became general. The U. S. Department of Justice entered a suit against the Standard Oil Company, and was considering similar measures against other large corporations. Still the American Telephone and Telegraph Company took over the Western Union Telegraph Company,⁸ and advertised: "One policy, one system, universal service."

In 1911, all telephone and telegraph companies whose subscribers could talk from one State to another came under the jurisdiction of the Interstate Commerce Commission, which began the institution of a uniform accounting system for telephone companies. A great many States then created commissions and began to regulate telephone rates and practices. The Bell Companies continued to buy up as many independent companies as they could, and the conflict between the two interests continued. Finally the Independents, who had formed a national association, appealed to the Department of Justice. Then the American Telephone and Telegraph Company "wishing to put their affairs beyond fair criticism," and in compliance with the suggestions of the Attorney General, agreed to dispose of their holdings and control of the Western Union, to acquire no independent companies, and to arrange to give independent subscribers toll line service. Since 1914, Bell and Inde-

pendent interests have really cooperated, adjusting duplicate situations by exchanges of property, the Bell taking over Independent plant in one city, and Independents taking over Bell in another, and using the long lines in common.

While local facilities were thus being multiplied and co-ordinated, long distance facilities also were being developed. From a small number of Eastern cities bounded, in 1889, by Boston, Buffalo and Washington, D. C., long lines were extended to Chicago, in the fall of '92. Demonstration calls over this new circuit were one of the most popular features of the Columbian Exposition held there the next spring.⁹ Technical difficulties in transporting such a delicate thing as speech over wires more than a thousand miles long, delayed further extension of long distance service for several years, but by 1911, the introduction in telephone lines of loading coils, regularly spaced at intervals of a few miles, made it possible to speak from New York to Denver. In 1915, half a year after the Panama Canal was opened,¹⁰ thanks to newly developed vacuum tube amplifiers, one could speak all the way from one coast to the other. In characteristic Bell fashion, this transcontinental service was opened just in time to be demonstrated to the public at the Pan-American Exposition held in San Francisco.

As part of the program connected with the inauguration of coast-to-coast telephone service, the Liberty Bell, which had not been sounded since it tolled for the death of Chief Justice John Marshall, eighty years before, was heard all the way from Philadelphia to San Francisco.

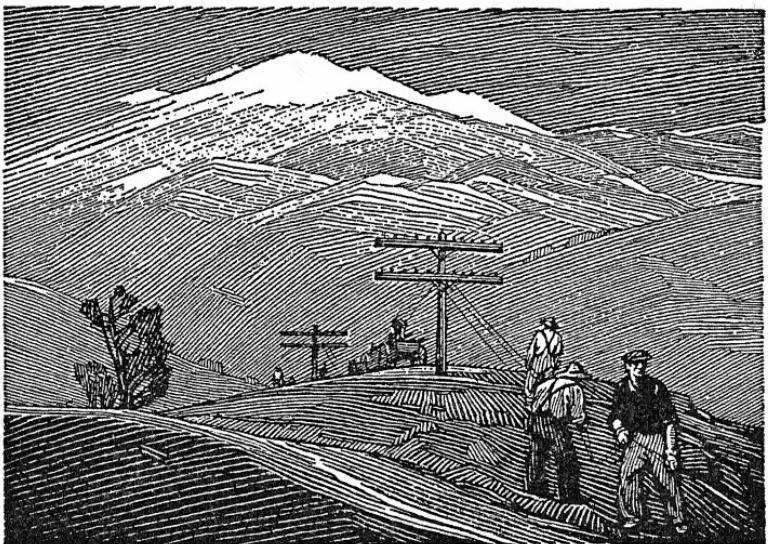
When, two years later, the United States entered the World War, a tremendous demand for telephone facilities was suddenly created. From a dull city, telephonically, Washington instantly became a violently active center for

calls to and from all forty-eight States. Factories and transportation facilities all over the country multiplied their activities many fold. Army camps sprang up like mushrooms, creating a need for means of communication such as had never been known before. And the telephone was ready to meet almost any demand made upon it. The nation-wide network of combined Independent and Bell telephone lines was readily and rapidly expanded. In addition to this, a large staff of trained personnel was immediately available for emergency duty overseas. With the well-developed telephone system at its disposal, the government was able to mobilize men, materials, and machines with amazing speed. By Act of Congress, this system was put under government control in August 1918, but the following year all wires were returned to their respective owners, federal authorities apparently having been convinced that nothing was to be gained, in either profit or service, by their continued administration.

The telephone was not, of course, a solitary isolated invention. Following close upon it, and developing with it, came electric power and light, structural steel, typewriters, automobiles, airplanes and radio. It cannot be said, therefore, that the American people accomplished this or that by means of the telephone, but the telephone certainly has played an important part in the significant changes, which have come about in American life during the past half century—economic changes, social changes, cultural changes.¹¹

Nowhere else in the world does there exist a nation-wide telephone network such as ours, uniting farms and small communities throughout the country with each other and with cities; nor are any other people as noted as we Americans are, today, for quick tempo and high standards of

living, for a sense of national security and a uniformly enlightened public. Inherent in our character is a firm belief that true progress depends upon a free exchange of knowledge and ideas, and our telephone system makes it possible for us to put this faith into practice.



Extending Telephone Lines across the Country

CHAPTER III

WHAT HAPPENED TO THE TELEPHONE ABROAD

THE RAPIDITY WITH WHICH TELEPHONES WERE INTRODUCED to the far places of the earth is rather surprising. Ardent promoters carried them, very early in their development, not only to European capitals but also to busy ports and large cities throughout the world. By the early 'eighties Cairo, Capetown and Calcutta, Bombay, Rangoon and Colombo, Shanghai, Honolulu and Buenos Aires, to mention only a few of them, all had some sort of local telephone facilities. The American interests of Edison and Bell were the first protagonists,¹ but soon several European concerns also began manufacturing telephone apparatus, and competing for operating franchises in different places. British promoters, with a goodly supply of capital available for foreign investment, established many telephone systems in South America, Australia, Asia and Africa. Rival inventors, manufacturers and operating companies made for keen competition and lively expansion.

Conditions were not, however, so right for telephone development in the rest of the world as they were in the United States. Canada, for example, was as yet too sparsely settled, and the population was a rather uncommunicative mixture of English, French, Eskimo and Indian. Sparse and mixed populations, together with the stormy Andes and the Amazon jungles, discouraged development in South America. India and China were densely populated but

economically backward. Africa's problems were also economic, as well as geographic. In Europe, the chief difficulties were political and linguistic differences.

Europe consisted, in the early 'eighties, of a score or more of different nations, each with a different government, each with its own zealously guarded boundaries and national interests. Germany and Italy had but recently achieved a degree of political unification; Spain had but recently emerged from a civil war; France, from a war with Prussia, and a brief but terrifying socialist commune regime. Bismarck was reshuffling the Balkans after a Turko-Russian war, in which England had supported Turkey. There was great social unrest, with strikes, anarchy, and anti-Semitic agitations. Germany and Russia were most active in industrial and naval expansion. Britain and Germany were bitter rivals for colonies in Africa. Here was no opportunity for efficiently co-ordinated effort.

Furthermore, though European cities were closer together and more densely populated than American ones, they did not have such a large and prosperous middle class. And, what was perhaps most important of all, they had very little uniformity of language. The comfort-loving German of Bavaria could read a telegram easily enough, which came from an energetic Hanseatic burgher, but they could scarcely understand each other's speech. Even in the limited area of the British Isles, in addition to the Scotch, Irish, Welsh and English were the peculiar speech vagaries of the different counties, so that the countrymen from Shropshire, Yorkshire or Devon could hardly carry on a conversation with the Cockney from London or the gentleman whose patois was the King's English.

Under such conditions, the development of the telephone

abroad was rather different from what it was in the United States; this manifested itself conspicuously in four ways. There was much more government control and much less standardization. There was much greater concentration of facilities in large cities, with practically none in rural districts, and there was very little long distance service.

In Germany, the telephone was under Post Office management from the beginning; since the telephone did not require trained operators as the telegraph did, Bismarck had seen it as a way of extending cheaper communication facilities into rural communities; public telephones were to be found only in government Post Offices and, for some time, little attention was paid to developing exchanges; telephone operators were recruited from the ranks of superannuated letter carriers.

In most other countries, however, private promoters were allowed to do the pioneer work of establishing telephone systems, and then the government took them over.

In the Near East, and in China, telephone promoters had to become reconciled with gods as well as governors. The leading ecclesiastics of a state in the Arabian desert were gravely concerned lest such a thing as the telephone might give offense to Allah. "Suppose," it was therefore suggested, "we have an expounder of the law of Islam stand at one telephone and read the Koran into it. Let another listen at the other end of the line. If the wires carry the sacred words, surely the telephone is lawful and of Allah." After this test was made there was no further objection. In China also, it was feared that the poles for the "speaking-lightning-sounds" sticking up in the air, might offend the wind spirit, Fungshui. When a telephone exchange was first opened in Constantinople, the agents of the operating

company had to buy two sheep to offer up with all due ritual as slaughtered sacrifice.

Government operation of the telephone in some countries, notably Japan, Albania and several places in Africa, meant that only the government could use it at first, but this was the exception. As a rule, it meant that like the telegraph, the telephone system was under the jurisdiction of the Postmaster General or a special ministry of communications. The officials who happened to be in charge were usually political appointees with little experience to qualify them for the operation, maintenance and additions which a telephone system required. Under them were the government clerks, to whom more telephones meant more work but no more pay. It was difficult to plan for expansion on such an uncertain basis as government appropriations.

The various manufacturers of telephone apparatus and equipment all had salesmen, of varying degrees of ability, promoting products of varying degrees of excellence. The allotting of contracts was sometimes influenced by forces other than the best interests of telephone service. All in all, the complete lack of standardization in telephone systems abroad, for almost fifty years, was a natural consequence.²

Some of the smaller European nations made better telephone progress than larger ones. It seems as if the rivers, fjords and mountains, which made wheel traffic so difficult in Scandinavia and Switzerland, may have favored the telephone; several native sons of outstanding character, ability and initiative in those countries promoted it wisely and well. Stockholm, standing at a junction of lake and sea and occupying many small islands, in its cooperative system had

over four telephones per hundred population when London had less than one. Denmark, under a private company, developed a party-line system which afforded both efficient and economical telephone service. In Norway also, telephone facilities were provided for smaller communities as well as large. "Whenever two or three Swedes, Danes, Norwegians or Finns gather together they establish immediately a church, a school, and a telephone exchange," people used to remark, "whatever else in life is worth having, comes later."

The Swiss Alps were crisscrossed very early with an inexpensive telephone system, which carried upward of fifty million conversations a year, and the monks of St. Bernard had equipped their mountain with a series of telephones, to further the safety of travelers.

Among the European capitals, in 1895, Berlin had the largest telephone exchange. It served 25,000 phones in the city and 3000 in the suburbs. So popular had the telephone become in Germany, it was pointed out, that commercial travelers were accustomed to standing several rows deep in hotel telephone rooms, waiting their turn at the "Fernsprecher."

Quite generally, outside of the United States, as late as 1914, only the most important Central Offices kept operators on duty during the luncheon interval, or for more than a few morning hours on Sundays or holidays. Night service was given only in the larger cities, and operators were not notably obliging. Such long distance calls as were possible, according to customary practice, were filed on a waiting list, and extra fees were charged for expediting them. "The voice with a smile" and all that sort of thing was not developed abroad.

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Neither were domestic and rural telephones promoted abroad as they were in the United States. About one third of the phones of France and Great Britain were in Paris and London. With populations per square mile of almost two hundred and four hundred persons respectively, France had only one telephone for each hundred and twenty-five people, and Great Britain, two. Germany had about one phone for every twenty persons in her larger cities, but one for every eighty elsewhere. At this time, rural and urban districts of Norway, Denmark, Sweden and Switzerland, averaged about twenty-eight persons to a phone.

Surprisingly enough, Australia, New Zealand and Hawaii had as many telephones per hundred population as the most highly developed countries of Europe. Remarkable progress had also been made, after 1900, in Canada; there was one phone for every fifteen persons when there were on the average only two inhabitants per square mile.³ In South America, Africa and Asia, however, were hundreds of millions of people who had never even seen a telephone.⁴

Long distance calls were limited to a few hundred miles; vacuum tube repeaters, the devices that made possible the extension of long distance telephone service across the American continent in 1915, were not introduced, at once, in telephone circuits abroad. The total number of miles of telephone wire in Europe was half of that in the United States. International telephone communication had been inaugurated in Europe by a line between Paris and Brussels, opened to the public in 1887. Within a month or so Amsterdam had been added, and four years later the first long distance submarine cable had been laid across the English Channel between Dover and Calais to connect Paris and London by telephone. Not until 1914, however, were

Englishmen able to telephone to Switzerland, a distance of about only five hundred miles, and even at such relatively close range, the time it took to make connections and the quality of transmission was far from satisfactory.

French, British and Italians marveled at the quality and efficiency of the telephone service established by the United States Army Signal Corps and American girl operators when they arrived in France in 1917-18. Lines were built immediately by the Signal Corps, over which it was possible, for the first time, to talk from Paris to Rome, and from Marseilles in the south of France, north to Le Havre, across the Channel to London, and on to Liverpool on the Irish Sea. These new lines extended west as far as Brest, and east as far as Germany, and were constructed so as to be adequate for talking with Berlin.⁵

After five years of an unprecedented movement of men, our planet seemed like a much smaller place than it ever had before. Great numbers of ordinary, everyday working people from all continents⁶ for the first time in history had traveled abroad, lived and worked together, and returned again to their homelands, with new hope for a more neighborly world. A large number of international business contacts were established either newly or more closely. The tourist trade started. International conventions and conferences of all sorts were held. Cooperation between the intellectuals of various countries was promoted. The telephone was scheduled to play a leading part in this rapprochement.

The President of the British Institute of Electrical Engineers voiced a growing sentiment when he said in his inaugural address in 1922 : "One way of increasing good will among nations, especially necessary to be encouraged by

all means possible at the present time, is by greater and ever greater intercommunication by all methods. In the telephone we have the most perfect means of communication of which we know, immediate and perfect human speech, with all its tones and inflections, and the ability, by interchange of conversation, to remove misunderstandings. If only we will use it, we shall be making a definite step toward reducing international jealousies and fears, and increasing good will, without which there cannot be peace on earth."

Technical developments made it possible the very next year for Bell System engineers to give a successful demonstration of transoceanic radiotelephony from their headquarters in New York City to a group of scientists and journalists in England. Although there seemed little likelihood of a volume of traffic sufficient to warrant it for some time to come, these were years of great prosperity and great optimism, and commercial transatlantic telephone service was inaugurated between New York and London, the two great financial centers of the world, in 1927. In another few months this radiotelephone service was extended to the principal countries of Western Europe. In 1928, Berlin opened service with Buenos Aires, almost seventy-five hundred miles across the Atlantic, and the next year saw London, Paris and Madrid also in direct radiotelephone communication with the Argentine capital. Netherlanders in Amsterdam were able to telephone their compatriots in Java; and Americans, not only in New York but almost anywhere in the United States or Mexico, could be connected with most of the principal cities of Europe.

This development of radiotelephony gave added stimulus to the development of both local and long distance wire

telephony. The Comité Consultatif International Téléphonique had been established in 1924. It had no legal or official power to make regulations, but its recommendations, representing as they did, the consensus of opinion of experts throughout the world, were quite generally followed. During the next ten or fifteen years remarkable advances were made in the telephone abroad. Both the number of telephones and the number of miles of telephone wire, outside of the United States, more than doubled; the total number of telephone conversations also more than doubled, while introduction of dialing and other automatic features vastly improved the quality of service. Telephone booths, or "kiosks," as they are frequently called abroad, were set up in considerable numbers along city streets and at country crossroads, and added greatly to the convenience of telephone users.

Whereas, in 1925, commercial facilities were available for international calls between very few of the more important cities of Europe, in 1939 any subscriber in any country, with very few exceptions, could have been connected with any subscriber in any other country. Even Iceland had a good telephone system, which united it with Europe, in spite of its geographical isolation.

Expansion and improvements all over the continent notwithstanding, Sweden, Denmark and Switzerland still continued to have by far the best telephone service in Europe. The British Post Office, as a special feature of King George V's Silver Jubilee, in 1935, had installed a considerable number of kiosks in the villages of England, North Ireland, Wales and Scotland; but there were still less than seven telephones per hundred people, as compared with twelve for Sweden and Denmark. There had been little commer-

cial development of telephone service in Germany after Hitler came to power, for he had, by the taxes imposed upon it, in effect classified the telephone with luxuries, which were to be given up in favor of military matériel. One of the cardinal points in Mussolini's program had been the gradual abolition of unprofitable government ownership, and he had, accordingly, lost no time in transferring the operation of the telephone from the government to private companies, each with rights in specified areas, and all associated with a single government system for long distance national and international service. Under the new management, the total number of telephones in Italy had increased from some one hundred and fifty thousand to over six hundred thousand, but this still meant only about one and a half phones per hundred Italians. The French government had tripled the total number of phones in France, in the interim between wars, but there were still only three and three quarter phones per hundred Frenchmen, and a quarter of these were still in Paris.

Like Italy, Greece, Rumania and Spain had all contracted with private companies for their telephone service. Unlike Italy, however, these three countries had conceded the telephone rights to foreign companies. Greece to a German-Swedish concern; Rumania and Spain to the American controlled International Telephone and Telegraph Corporation.⁷

The Belgian government, and the Russian Peoples' Commissariat for Postal and Electrical Communication increased the number of telephones in their respective countries approximately six fold in the 'twenties and 'thirties. Rather interestingly, tiny Belgium and enormous Russia have the same total mileage of telephone wire. The average num-

ber of telephones per hundred population, as of January 1, 1939, was 2.67 for Europe, as compared with 15.37 for the United States.

In Africa, between 1925 and 1939, the number of telephones and mileage of telephone wire trebled.⁸ More than half of this development, totaling about two hundred thousand phones, was carried on by the British, in the Union of South Africa. In Asia, during the same period, over a billion people came to have about two million telephones.⁹ With less than one tenth of a per cent of the area, and about six per cent of the population of the continent of Asia, the Japanese, by exercise of their own inherent energy and consummate esprit de corps, had developed over seventy per cent of these. Per hundred population, Japan had more telephones than Italy; the total number of telephones in Japan was more than half again as many as in all of South America.

The recent attitude of the Japanese Ministry of Communications has been similar to that of the German government. During the year ending March 31, 1939, nearly a million applications for new telephones were received from all over Japan; thirty-six thousand of these were drawn by lot to be granted but, due to a shortage of copper, that number was cut in half. Then priority in installation was, of course, given to those connected with war industries, national defense and general mobilization.

The Indian Government, a few years ago, appropriated more than twenty-five million rupees for telephone development principally in the Delhi, Calcutta, Bombay and Madras areas. In China, part of the British share of the Boxer Indemnity Fund was designated for use in improving long distance telephone facilities by the addition of high-

power, short-wave, radiotelephone stations, but the war interfered with this, and what telephone communication there now is in China is confined chiefly to the foreign settlements and treaty ports.

The average Oriental has something like contempt for Western mechanical devices designed to do things "efficiently." There are so many millions of human beings trying to earn a little rice! And telephones mean empty bowls to a multitude of "chit boys," who used to carry messages back and forth for foreigners and wealthy natives. A Hindu philosopher asks, "What difference does it make where the body may be, if the mind be not developed? Why should one desire to communicate with others by wire, if one's mind is not attuned to the psychic waves that come from the action of their minds?" A Japanese journalist writes:

Western civilization, dominated by the machine and the passion for comfort, offers no solution to the great problems of inherent permanent national stability, serenity of spirit, and man's greatest achievement, the conquest of himself. Triumphant man may not be revealed, in the end, adorned in a top hat and attached to a telephone. Asia has a civilization of her own.

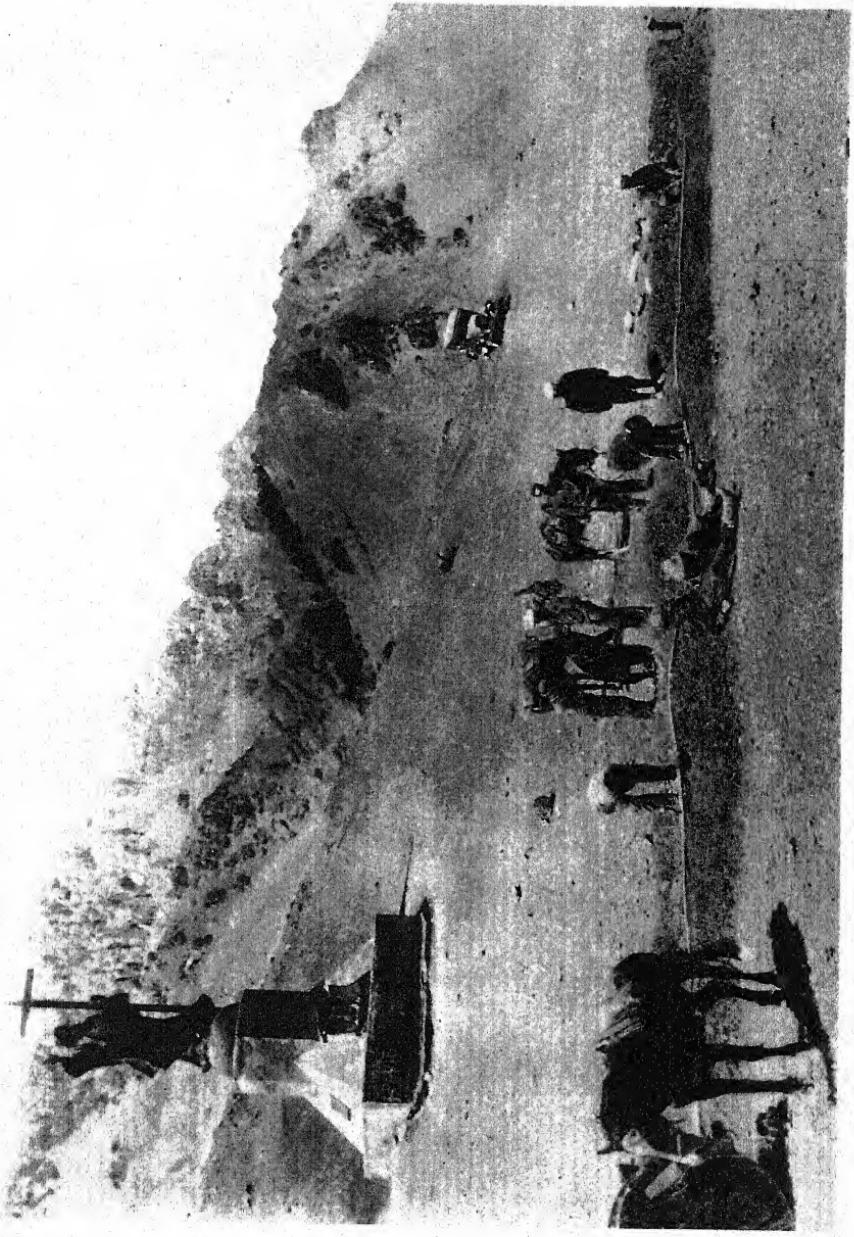
In the Western Hemisphere, two tremendous telephone projects were completed in 1928. A new transcontinental telephone service was opened in both North and South America. For the first time, all the Canadian provinces were united in a dominion-wide network, with lines running all the way from Halifax to Vancouver; and a cable from Santiago, Chile, across the towering and stormy Andes to the Argentine capital, Buenos Aires, and under the broad

estuary of the La Plata, to Uruguay's capital, Montevideo, introduced international telephone service to South America.

The gold and silver that had lured the early Spanish and Portuguese explorers had long since been surpassed in value, a multitude of times, by the annual exports of bananas, coffee, wheat and meat, arranged for by the businessmen and diplomats, who had come to South America from Italy, Germany, Japan and the United States. Various foreign interests and native governments had operated telephones locally in some of the ports and capital cities, from the early 'eighties, but, in 1927, in all of South America there were less than half as many telephones as in the city of Chicago. More than a quarter of all the South American phones were in Buenos Aires.

Argentina, with much better climate and fewer natural obstacles to economic growth than other South American countries, had had the best telephone facilities, as well as the most profitable trade, for half a century. It was the development of commercially practicable radiotelephony, however, coinciding with the post-war interest in expanding world markets, that brought about a noteworthy expansion of telephone communication throughout the continent.

During the decade following the inauguration of international telephony in South America and radiotelephone service with Europe and the United States, the total South American mileage of telephone wire almost trebled; the total number of phones increased more than ninety per cent. While expansion took place in Argentina also, it was most noticeable in Southern Brazil, Chile, Paraguay and Peru. This activity was due largely to the International Telephone and Telegraph Corporation, and the favorable rela-



Laying the Trans-Andean cable between Buenos Aires and Santiago



S.O.S. telephones in Switzerland

tions it succeeded in creating through its understanding representatives, and its modern apparatus and equipment. Local officials and businessmen were pleased to be thought of as "local citizens" instead of as "natives;" as Argentinians, Brazilians, or Chileans instead of as "Latin Americans;" and they were well satisfied with the noticeable increase in business which the new telephone systems afforded. While these people have been, and still are, very proud of their nationality, and Brazilians dislike intensely to be addressed in Spanish instead of their native Portuguese, thanks in part to their association with the telephone, they are developing more pan-American spirit. Their telephone facilities are now adequate for any rapprochement which world events may bring.

Telephone training schools for installers, linemen and repairmen, which pay students while they study, have disclosed a great deal of technical aptitude, previously unsuspected, in South American youths; many other sorts of technical schools and courses have been started as a result. Since the traditional attitude has been such as to discourage girls from working outside the home in Latin countries, it was difficult at first to get good operators. Experience, however, has shown the South American, as it has others, that the operators are the basis of the whole telephone system, and that the quality of service depends largely upon them; this has greatly increased the operator's prestige, and opened up a new life for many girls. Where dials are in use, as they are in many South American countries, though operators are fewer, they must be more skillful and more pleasing, and are therefore held in higher esteem than the operators in manual exchanges.

Because telephone development abroad was less and later

than in the United States, the operating problems associated with it have been of smaller magnitude. While the telephone system of the United States included approximately half of all the telephones and telephone wire in the world, the German system, next largest, included about ten per cent; Great Britain's, about eight; no other country had to worry about as much as four per cent of the world's telephones or telephone wire. While the volume of telephone traffic in the United States was 28,800,000,000 conversations a year, Japan, ranking second in this respect, handled 5,339,-000,000 calls; Germany, 3,500,000,000, Canada, 2,500,000,-000, and all other countries a substantially smaller number of calls. This retarded telephone development abroad has not, however, been entirely to the disadvantage of subscribers. It has meant that they were offered special, though extraneous, services and features which many American companies were too busy to bother with. Parisians, when Paris was France, found the telephone administration offering them secretarial, shopping and messenger services, in addition to the conventional communication service.¹⁰

In Switzerland, you could have your telephone operator waken you every morning, or you could take your pick of radio programs, not only from Swiss stations, but also from French, German, Italian or British, by pushing a button connected with your telephone.

The German Propaganda Ministry made available to telephone subscribers, cheap radio receivers to be attached to their telephone lines for staticless reception of official programs. Though very rarely used, television phones were also operated, on special circuits between Hamburg, Berlin, Leipzig and Munich; over these, two people could see each other while they were talking. Highway call

boards for motorists were another special feature of the Reich's telephone service. These were set up along Hitler's new motor roads to announce to passing motorists that owners of such and such license numbers were wanted on the telephone. When they stopped at the nearest telephone station they were able to take the call.

Stockholm and Copenhagen had special exchanges for persons wishing to order a cab. A telephone box at each taxi stand made it possible for the operator to get in touch with a driver at the stand nearest the person ordering. The driver of an only cab at a stand closed the door of the call box when he left, and this signaled to the operator that no taxis were available at that particular stand.

The Swedish telephone administration, upon request, furnished subscribers with wax recordings of their long distance calls.

The British Post Office, for promotion purposes, emphasized an esthetic note in telephone service ; they offered subscribers handsets colored to match the home decorations, and a "perfect telephone bell," chosen by a jury of musicians, the pleasing tone of which could be well heard but would never make a nervous subscriber jump. The design of the Jubilee kiosks won the approval of the Fine Arts Commission, and the Organizations for the Preservation of Rural England and Wales, and Rural Scotland. These booths contained mirrors which were supposed to offset the tendency of users to scribble and doodle on walls and directories.

Shanghai's eighty thousand telephone subscribers have been offered a burglar alarm, buyers' guide, typhoon warning, time of day, and "if no answer, call" service.

In Japanese restaurants, ice-skating rinks, theatre lobbies

and other public places, a continual blare of loudspeakers may be heard announcing telephone calls being held for patrons. This system is approved because so few people can have telephones in their homes.

The retarded development of the telephone abroad was also of advantage to subscribers in another and more important way. Because operating agencies abroad did not have such large investments in existing "plant," and had not committed themselves to a policy of uniform and universal service, they were much more free to introduce new inventions and improvements as they came along. When they wished to introduce a new type of subscriber's instrument, such as the handset, for example, it did not mean that they would have to scrap several million desk stands that subscribers were already contentedly using, and which were made to give many more years of service. When they wished to introduce automatic exchanges, they did not face such enormous expense, such complex problems of carrying on uninterrupted service during the transition, or such a large and well-trained force of operators who would have to be superseded. Instead of objecting to the replacement of operators, as a matter of fact, European telephone users, in general, were relieved to be rid of them.

Dials began taking the place of operators abroad soon after nineteen hundred. Before 1912, German, French and British firms all had acquired manufacturing rights from the Strowger Automatic Electric Company of Chicago and, during the next decade, automatic telephone systems were installed even in such unexpected places as Mesopotamia, for one thousand subscribers' lines; India, for fifteen thousand; South America, for seventeen thousand five hundred; South Africa, for eighty; China, about nine thousand;

Japan, two hundred and five; and the Straits Settlements, for forty subscribers' lines.

Language differences made dial phones most welcome, and the fact that they offered twenty-four hour service even in places where the expense of night operators had not been thought justified, also helped to account for their rapid spread. By 1939, sixty-four per cent of the phones in Europe were automatic, sixty-three per cent in South America, fifty-seven per cent in Africa, fifty per cent in Oceania and forty-two per cent in Asia; fifty-three per cent of all the phones in the world. It seems strange to us that places like Jerusalem and Shanghai should have more modern telephone equipment than many American cities—air-conditioned it is in Shanghai—but even stranger that one could dial a call in Southern Rhodesian towns¹¹ named Umtali, Umvuma, Bulawayo and Lalapanzi, before New York City was fully automatic. In Belgium, toll, as well as local, calls were handled completely automatically—even the ticketing, coin collecting and coin counting.

The question of whether or not governments should advertise their telephone service, or simply let people ask for it if they want it, has been much discussed in Europe; conclusions have differed from time to time and from country to country. Most promotional advertising has come from organizations of telephone equipment manufacturers, such as the Telephone Development Association in England, and "Pro Telephone" in Switzerland. In New Zealand, however, for a while the Post Offices were canceling stamps on letters with the caption, "The Telephone Banishes Loneliness;" and when the telephone cable from Australia to Tasmania was put in service, the Australian Government issued a commemorative postage stamp.

Telephone rates are difficult to compare from country to country. With rates of exchange fluctuating so much, and living conditions varying so much between different countries, monetary comparisons based on par, or on current exchange rates, have little or no meaning. Furthermore, rate schedules are constructed according to different principles. Instead of a subscription rate including a definite or an unlimited number of calls, as it usually does in this country, it is quite customary abroad to have a fixed rental fee for the apparatus, and an extra charge for every call. In Germany, the idea has been to charge each subscriber exactly according to the amount of apparatus and operator's time he uses. In Copenhagen, subscribers may contract for blocks of 1000, 2000 or 3000 conversations per year, and are charged accordingly. In most places, the rates are lower for residence than for business phones; this is supposed to "temper the wind to the shorn lamb," and to promote the use of the telephone in homes. As yet, however, the ratio of residence to business phones abroad is very low.

One might expect that to balance this situation, coin box phones would be found in larger numbers abroad, but not so. One reason is that people abroad do not have the telephone habit as Americans do; they still write letters and have endless processions of order boys: another, is the great variety of coinage. This is a special difficulty near international borders, where one country is apt to have a copper coin the same size as another's silver one. In some cities, grooved slugs were made and sold to obviate this difficulty.¹²

The most unique system of telephone charges is Japan's. There the Ministry of Communications may announce that

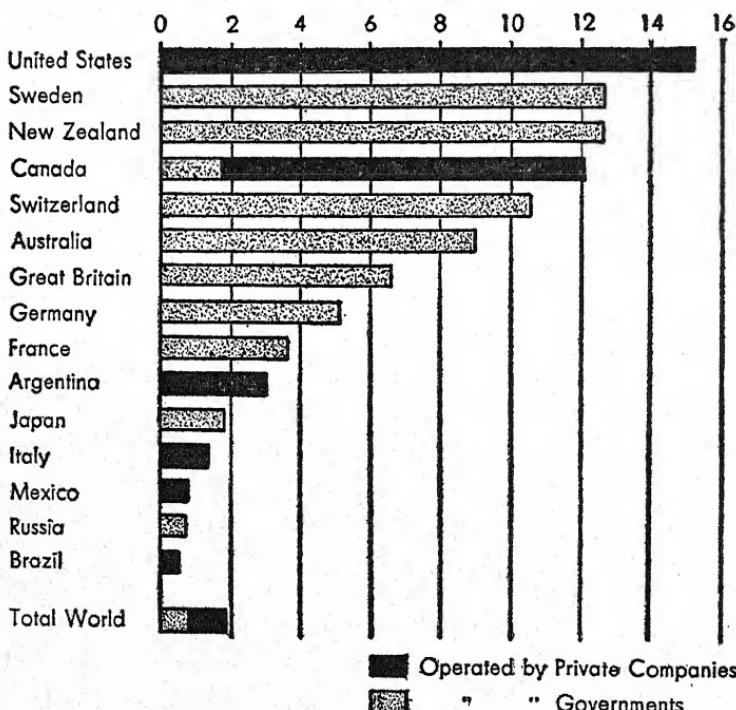
the cost of a telephone is, say, four hundred yen. You buy the telephone and then pay service charges every month. Since the Ministry of Communications often takes several years to consider an application and install a telephone, however, the standard procedure is to get one from a broker who buys up the phones (instruments and numbers) of people who are moving or, for other reasons, giving them up. The broker charges, perhaps, a thousand yen for getting you a phone at once. If the number is a "lucky" one or especially easy to remember, the price is usually higher. Then to counteract this undemocratic situation, the Post Office for many years conducted a lottery. Millions of people submitted their names, addresses, occupations and nearest telephones, in the hope of winning a telephone of their own which they could have installed for about ten yen. When they began to make a practice of selling the phones that they won, at handsome profits, a law was passed prohibiting this sort of resale, and as the Chinese "incident" dragged on, the lottery was discontinued. It has become almost impossible to get a telephone, for either love or money. A person who owns one, counts it a valuable part of his estate, to be used as collateral if need be, or willed to his heirs when he passes on.

The aims of the pioneers who carried the first telephones throughout the world have to a large extent been fulfilled. The telephone has indeed been developed into a superb instrument of communication. It has helped to coordinate business and make possible mass production and swift interchange of goods. It has become so essential to political and military organization that Hitler has shown greater concern for the telephone systems than for the national banks of invaded countries. Where it has made its way

into people's homes, it has usually proved to be a faithful friend. As to uniting all mankind in a common brotherhood—that fond dream of a generation ago—well, the world-wide telephone networks are ready to transmit whatever messages we wish to speak.

TELEPHONES PER 100 POPULATION

January 1, 1939



CHAPTER IV

THE TELEPHONE IN AMERICAN LIFE TODAY

FOR THE TELEPHONE SERVICE IN THE UNITED STATES TODAY, the Bell System is largely responsible. Of this tremendous organization, a recent writer, connected with the Federal Communications Commission has given us the following brief but comprehensive and startling description :

The Bell System is, in many ways, the finest example of capitalism at its best. Its history shows what private initiative has done. Its future is a matter of momentous public importance.

The five-billion-dollar Bell System, controlled by the American Telephone and Telegraph Company, is the largest aggregation of capital ever controlled by a single company in the history of private business enterprise. Consisting of two hundred separate corporations, this system controls 83% of the telephone stations in service, 91% of the telephone plant and 90% of the total telephone revenues in the United States. It controls 98% of the long distance telephone wires in this country and practically all the wire facilities used in radio transmission. It has a complete monopoly on transoceanic radiotelephony. Most of the press and all of the telephotograph service is dependent upon this system.

Through its wholly owned subsidiary, the Western Electric Company, the system manufactures more than 90% of telephone equipment. It controls the supply of teletype machines. A large part of the motion picture industry has depended since 1927 on Western Electric sound-recording equipment; and through Western Electric's subsidiary, Electrical Research

Products, the Bell System divides with the Radio Corporation of America the sound reproduction equipment business. Furthermore, the American Telephone and Telegraph Company has loaned millions of dollars to producers and exhibitors of sound motion pictures.

Sixteen million telephone users obtain their service from the Bell System. The holding company for this system, the American Telephone and Telegraph, has nearly 650,000 stockholders. The system is one of the largest employers of labor in America. Its annual purchases of raw materials run into hundreds of millions of dollars. Using almost a third of the active banks in the United States, it is one of the largest depositors of liquid capital.¹

But in addition to the Bell System, though Eastern city folks often do not realize it, there are more than 6500 separate and independent telephone companies, which are neither owned nor controlled by it, and which operate about one fifth of the telephones in this country. Minnesota alone has 1700 independent companies in addition to the Northwestern Bell Telephone Company. Various ones of these companies serve from as few as four, to as many as half a million, subscribers each.

In striking contrast to the giant Bell System is what is possibly the smallest independent telephone company at Pope Mills, New York, about fifteen miles from Ogdensburg and the St. Lawrence River. This company was started around the turn of the century and has continued to exist in spite of the fact that the cutting through of highways has spoiled its right of way for pole lines, and its number of subscribers has diminished to four. The widow of the founder is president, business manager, and operator for the company now. Her central office is in the general store, and the storekeeper operates the switch-

board, when she has to be away on her other job, driving the local school bus.

To complete the picture of our nation-wide telephone service, 40,000 more rural lines and systems, privately or cooperatively owned and operated, must also be included.

All of these together add up to a total of well over twenty million telephones in the United States, any one of which can be connected promptly with any other.

We Americans use these phones for making, on an average, more than ninety-five million calls a day—that is over twice the number of all the letters, post cards and telegrams we send. Almost four hundred thousand men and women, executives, statisticians, inventors, engineers, typists and clerks, operators, installers, linemen, mechanics, factory workers, etc., men and women of many sorts of talent and many walks of life have to cooperate to make our telephone service possible. The job of planning the methods, materials and mechanisms of the telephone system requires specialized knowledge not only in the physical sciences for making improvements in apparatus, but also in economics, in the growth and movement of population, and in social trends, so that adequate, but not extravagant, facilities may be available at all times. To offer satisfactory service in addition to adequate equipment requires a superior personnel with a fine esprit de corps and very good training.

Equally as astonishing as the personal element of our nation-wide telephone system is the part known simply as "plant." Together with land and buildings, rights of way, vehicles, tools, office furniture, etc. this includes powerful generators and delicate relays, rugged cables and armature windings of wire finer than hair, great banks of clicking automatic switches and millions of tiny flashing switch-

board lamps, billions of miles of wire, and poles enough to build a solid fence across our continent! Trillions of parts working together smoothly!

An order for one new telephone creates a demand for more than thirty different raw materials which go into it, and when this order is duplicated by thousands of others all over the United States, trains, trucks, ships and planes, are kept busy carrying supplies to the several large manufacturers of telephone apparatus and equipment,² and distributing the finished parts to the many warehouses scattered throughout the country.

Surprising as it may seem to those of us inclined to think of the telephone system as made up of poles and wires and the black instruments on our desks or tables, paper is probably the largest item on the telephone companies' annual order list. There is the linen paper which is wound around strips of aluminum to make the telephone condenser. Much of this is made of scraps from linen factories, and rags from worn-out tablecloths, dresses and bedding, which have been imported from Ireland, Belgium and Russia. Then there is the hemp paper used for insulating the separate wires in some types of cables; old pieces of rope which have served their day on ships and farms go into this, together with cotton and wood fiber.³ A third kind of paper, by an interesting chemical process, is made into carbon filaments for switchboard lamps. There are also: the paper discs stamped with your number on the front of your telephone; over thirty thousand tons of directory paper; the stationery used for letters, checks, bills,⁴ records and publications of various sorts; carbon paper; paper towels and paper cups for the hundreds of thousands of telephone company employees.

Coal rolls into the telephone business by the fifty-ton carload from Southern Illinois, Indiana and Pennsylvania. The majority of it is consumed for heating, but two or three tons a year of specially selected and finely crushed coal is ground, sifted, washed and carefully roasted to make the carbon granules on which the operation of telephone transmitters depend.

The millions of magnets which start to control circuits, light lamps and ring bells, as soon as you pick up your telephone, require iron, which comes from Alabama and Illinois. Steel for structural framework, tools and many other purposes is manufactured in Pennsylvania. Carloads of copper for making wire and brass screws roll in from Utah, and lead for cable sheath, from the Ozark Mountains in southeastern Missouri. Nickel, for nontarnishable finishes, comes from the rich Sudbury mines in Canada and from New Caledonia, an island in the South Pacific Ocean. For the innumerable connections that must be soldered together, tin, to mix with lead, is brought in ships from Malaysia almost on the equator and the opposite side of the world.

In smaller quantities, antimony, to harden the lead sheaths for cable, is carried by llamas from the high Andean plateau of Bolivia. Zinc for alloys and paints is derived from New Jersey and Missouri; aluminum for foil and diaphragms, from Arkansas and the Guianas. Chromium is brought from Rhodesia in South Africa, tungsten from China and cobalt from South America. Gold for the center spot on the transmitter diaphragm may come from the Transvaal, Alaska, the Rocky Mountain States, or Mexico. Platinum, for contacts and small parts designed to withstand excessive wear, comes from the Sud-

bury mines in Canada, from the U. S. S. R., and Chaco in South America.

Formerly, many receiver shells and transmitter mouth-pieces were stamped out of sheet rubber, which Indians of the Amazon valley had a large part in producing, and were smoothed and burnished by diamonds mined in South Africa. Today's familiar handset type of instrument is molded of phenol plastic. The wear-resisting black paint on telephone instruments is made of asphalt from the great Pitch Lake of Trinidad, mixed with a resin called copal imported from Madagascar. Japanese silkworms supply the raw material for the braiding on many receiver cords; and Australian Merino sheep the wool for the felt pad on the instrument base; a little red insect that lives on the sap of the trees of India and Siam, and resembles an apple seed, is the source of shellac which serves the telephone system as an excellent nonconductor and an effective bar to dampness.

Longleaf yellow pine from the Gulf of Mexico swamps, where only cloven-hoofed oxen can pull a load through the sticky mud; northern white cedar from the Great Lakes region, cut in the fall and winter after the ice has formed, and floated down when it melts; Douglas fir; red cedar and lodgepole pine from the Northwest and Rocky Mountain States; all of them straight and tall and of specified diameter, when shorn of their branches and bark and treated with creosote, take their places about a hundred and fifty feet apart along the lines, and literally uphold the telephone service. The average telephone pole was a tree sixty years old when cut, and will give about twenty years of service in the Bell System. Some Southern-pine poles are known to have been in service for over forty years;

many more would have been, were it not for casualties, due to the widening of roads and automobile accidents.

And so on, and so on, men, women, animals, plants and insects all over the world, busy providing the raw materials to be manufactured into the more than a hundred and fifty thousand different kinds and sizes of individual parts that go into telephone apparatus. Since each part is expected to be capable of going into service anywhere in the system, and functioning properly with every other part, it is made according to standard specifications, and frequent inspections are made to check its conformance with these specifications.

The very inspection of telephone apparatus and equipment constitutes a special sort of engineering. No matter how hard a skilled worker in the factory tries, he can never make two parts which are exactly alike in every detail, and it may be wasteful to have him spend a great deal of time trying. From previous experience, certain limits can be worked out, beyond or within which it is both economical and efficient to allow important characteristics such as dimensions, tensile strength, chemical content or electrical resistance to vary. The cost of inspecting every single piece of most kinds of parts or apparatus would not be justified either, and inspecting for some things is destructive; testing fuses for their blowing strength, for example, destroys the fuse. Based on the mathematical theory of probability, therefore, together with experience, tables are worked out to show how large a sample should be tested to give a certain degree of assurance that not more than so many defective pieces will be found in a manufactured lot of a given size. Having developed both the theory and practice of inspection engineering and "quality assur-

ance" for its own purposes the Bell System has made its results available to other large industries through publications, and by cooperation with technical societies, such as the American Society for Testing Materials.

There is also a special testing of certain parts for weathering and wear. Facilities for this include open lots planted with wire strung poles, roof tops with sprinklers simulating rain, and rooms full of machines dropping handset mountings.

Three vast plants of the Western Electric Company, where the majority of telephone parts and equipment are made, cover hundreds of acres. They have their own railroad systems and docks where freighters may tie up. They have their own electric plants and water supply, several restaurants for employees, hospitals, a library and lecture rooms where workers may take special courses, baseball diamonds, tennis courts and gymnasia, all in addition to the regular factory buildings. And one must not forget the huge parking spaces for the cars the employees commute in.

After the various manufactured parts designed for service in the telephone system are passed by inspectors and shipped to the various distribution points they come into the hands of installers, linemen and repairmen, operators, maintenance crews, subscribers—or anyone with a nickel.

Altogether the American people spend about \$1,238,000,000 a year for telephone service. Of this the government receives in taxes about \$170,000,000 (over eighty cents per month per telephone) and 315,000 employees of the Bell and Independent telephone operating companies receive about \$540,000,000 a year in salaries.

What the American people think of their telephone system was clearly expressed in nearly two hundred editorials

appearing in daily papers throughout the country recently, when the report of the Federal Communications Commission, which was appointed to investigate the telephone business, was published. Although the commission exposed all the unsavory conditions it could find, ninety-five per cent of the editorial comment was favorable to the present telephone administration.

From the point of view of investors, the telephone is both interesting and important, and the American situation is quite unique. For almost half a century, telephone stock has been one of the world's leaders, and Bell System bonds are near the top of the list of high-grade interest-bearing securities in which banks and insurance companies invest the savings of their depositors. The majority of independent companies are financed by capital, local to their operating area, but some belong to holding companies such as the General Telephone Corporation. In any case, there is usually a widespread ownership in small holdings, and an unusual democracy of interest in the business.

Geographically, A. T. & T. stock is perhaps the most widely held single investment in the world. During earlier years the ownership of stock was naturally centered in Massachusetts, where the telephone was invented and first financed, but, as the Bell System grew and its nation-wide character became established, interest in its securities extended to all parts of the United States. Furthermore, it was soon recognized that the telephone industry could not be financed through the savings of any one section of the country and that a broad interest in the Bell System would be needed to provide the capital funds required for its growth. A few years ago there were 8000 stockholders in eighty-two foreign countries and United States possessions.⁵

While farming areas and small centers of population have done their part in supplying the capital needs to the telephone business, there is also a wide distribution of the stock in cities. For the most part, these stockholders are men and women who by their daily thrift have put aside small sums for investment; a large percentage of them are housewives and Bell System employees. No individual stockholder owns as much as one per cent of the total A. T. & T. stock.

The part the telephone plays in our nation's business by virtue of its needs for raw materials, its utilization of transportation facilities, its building program and its employment of so many people, not to mention its nine per cent dividend, is of relative insignificance, however, when one thinks of what it means in service to business, both big and small, to the press and government agencies; in safety to ships at sea and planes in the air; in security, time saving and satisfaction to those who remain at home, and in traveling time and fares to every user.

When big business wants to buy something in a hurry, it can immediately contact all possible sources of supply and discuss differences in quality, price and shipping date. By private telephone wires, all branches of its organization, no matter how scattered over the country they may be, keep in constant touch with each other's movements and co-ordinate them.⁸

Certainly one of the busiest big business telephone set-ups is that of the New York Stock Exchange. The way the telephone is used here, aside from the enormous quantity and speed of transaction which it makes possible, is interesting evidence of the faith American businessmen have in each other's spoken word. Buying and selling, "sight un-

seen," and the making of business deals involving large sums of money without written contracts, is one of the distinctly American practices quite directly traceable to the telephone.

A businessman wishing to invest some money, telephones his broker to discuss certain stocks. With the client still on the wire, the broker's clerk telephones the New York Stock Exchange Quotation Department for the bid and asked prices of the stock under consideration. When the client makes his decision, an order is placed by telephone from the broker's office to his representative on the floor of the Exchange.

The telephoned order is received at a "member's booth" of which there are about 1500, around the perimeter of the large trading arena, each connected by private telephone lines direct to brokers' offices. More than 130 telephones also connect the seventeen trading posts on the floor with the offices of members who specialize in certain stocks. During some five-hour days nearly two million calls are made to and from the floor of the exchange.

The Quotation Department, which is the information center concerning bid and asked prices for stock, is provided with specially designed telephone order tables for a hundred operators, and a special private-wire service makes it possible for members, wishing a quotation on a certain stock, to dial the code for that stock and be connected directly with the operator who has the desired information up-to-the-minute right on the tip of her tongue. As many as 25,000 calls are sometimes handled by these operators during the first half hour of trading.

Big business also uses the telephone in its lighter moments. To celebrate some occasion such as an anniversary, executives often like to have all their employees participate.

For example, Howard Heinz, son of the man who started grating and bottling horseradish as the first of "57 Varieties," on the occasion of that company's seventieth birthday, greeted nine thousand employees gathered in dining halls in sixty-nine different places from New York to California. Several other members of their organization were "called up" from dinners in New York, California and Canada.

To pep up its scattered representatives to a new sales campaign big business again uses the telephone. The sales executives of a large oil concern, recently called "Conference Service" to help them contact several thousand of their dealers, and when they were all on the line, described their merchandising plans for a new product. Electrolux executives frequently contact groups of salesmen in several showrooms in different areas by conference service hookups.

Conference service, however, is not reserved exclusively for big business. Anyone, by simply asking for "conference operator," may place a call for several other persons simultaneously, either within one local area or at remote points, and, in a short time, be connected with all of them at once, so that any one may speak and all may hear. Many widely scattered families have enjoyed talking together in this way, at Christmas time and on anniversaries. Brothers and sisters in the Philippines seemed just as near as those in California. And two grown men at opposite ends of Minnesota, who hadn't seen their mother in Norway for over fifty years, felt like boys again when they called her up on her eightieth birthday.

When family problems are to be solved, telephone conference service makes possible discussion and sharing of responsibility even though the members be far separated. An

instance of this occurred when a mother visiting one of her five children, all living in different cities, became seriously ill. The son whom she was visiting put through a conference call for his brothers and sisters and let the doctor discuss the situation with them all. As it happened, the mother did not survive the emergency operation which all agreed to. One son's relief that it had not been performed on his sole say-so can well be imagined. Many families have also found that the strain and confusion which attends the making of funeral arrangements with scattered relatives may be greatly relieved by asking for "conference operator."

Public officials and professional men, too, find telephone conference service efficient and economical. The California Prison Board, consisting of four members from widely scattered sections of the long state, holds its meetings in this way. The Pennsylvania Medical Society announced in its *Journal* recently, in an article entitled "Conserving Time, Energy and Money" that the busy members of its committees on Physical Therapy and Medical Economics, who find it difficult to leave their practices to attend distant meetings, have for some time been "meeting" by telephone conference hookups. It explains that before each hookup there must naturally be considerable "ground laying" in preparation by the chairman and other members taking part and goes on to say:

Without any attempt to pass on the value of the usual form of committee meeting, involving prolonged absence from home on the part of committee members, and the payment of travel expenses on the part of the State Society, its board of trustees respectfully recommends to State Society committees the appropriate use of the telephone conference.

The very first druggists, butchers and grocers to have telephones installed, of course, received telephone orders for goods to be delivered, and as the number of residential telephones increased, the number of telephone orders did also. As soon as private branch exchanges made it possible for larger stores to place telephones on every counter, they also began to promote telephone order service. As early as 1905, a department store in Philadelphia, Strawbridge & Clothier, was using full-page advertisements to tell about its 500-telephone interior system and to invite telephone orders.

The management of many stores were afraid that emphasis on this type of transaction would be undesirable because it would keep customers out of sight of the attractive displays and bargain counters which were so carefully designed to stimulate the shopper's desires and the store's sales, but a recent trend in telephone merchandising has proved that this need not be so. The larger stores nowadays have specially trained telephone order clerks to handle all telephone orders for all types of merchandise. These clerks are supplied with loose-leaf catalogs of nearly all the items the store carries, and attractive displays are arranged for them of the goods most frequently bought by telephone. They are thus well acquainted with the store's merchandise and have information right at hand so that they can talk convincingly with the calling customer. This type of service accounts for as much as ten per cent of the gross volume of sales in some of the larger city department stores. A recent study has shown that: telephone orders are at least as profitable as counter or mail orders; that the dollar volume on incoming telephone calls may be increased as much as twenty-five per cent by a reasonable amount of

suggestions and salesmanship ; that this helps rather than hurts the store's relations with its customers ; and that telephone order service brings the store much desirable business which it would not otherwise get. One large New York store now has over a hundred specially trained telephone order clerks with over a thousand telephones at their disposal, and another store has begun to advertise twenty-four hour a day telephone order service.

All of the radio advertising done by big business nowadays is also, of course, directly dependent upon the telephone networks which the broadcasting companies have at their disposal. These sponsored programs are carried by telephone lines between the various stations from which they are put on the air.

A Chicago county treasurer did some big business for his city by having his staff telephone to persons who were delinquent with their taxes. Letters and bills had done no good, but when they were personally and politely asked to pay, forty-one tax payers sent in checks amounting to over twenty-three thousand dollars.

Small businesses, also, have "big moments" by means of the telephone. The partners of a two-man export firm in New York like to tell how, just before the war, they received a telephone call one day soon after noon. It was from a Western manufacturer giving them an option on certain goods for the rest of that day. They thought the goods could be sold to a London dealer, but in London, owing to the five-hour difference in time, it was already after 5 P.M., less than an hour before the close of the business day. At 12:25 P.M. in New York—only thirty-five minutes before the 6 P.M. "deadline" in London—they called "Long Distance," asked for the overseas operator,

and gave her the name and address of the prospective customer in London.

"In four minutes we were talking by telephone to our prospect in London. He was out of his office when our call went through, but was located at tea in a nearby restaurant and spoke to us from there.

"Our conversation lasted four minutes and resulted in closing a deal netting us \$1340 profit. The cost of the telephone call was \$28."

On behalf of the small business man, also, and how he may use the telephone to improve his business, articles have been written for various trade journals and magazines such as *Office Life*, *Radio Retailing*, *Plumbing and Heating Journal*, *Butchers' Advocate*, *Independent Grocer*, and *National Delicatessen Grocer*. Most of these articles emphasize the need for expressing a pleasant telephone personality, answering calls promptly, with the name of the firm and the individual speaking, rather than with time-wasting "Hellos." If you identify yourself, promptly, such articles point out, more than likely the caller will tell you at once who he is. And if he doesn't they suggest that it is much better instead of asking "Who's this?" or "Who is calling?" to say, "May I tell Mr. So-and-So who is calling?" or "I am sorry but I did not get your name." In digest they go on to say something like this: "Guard against needless transferring from one extension to another—offer to call the person back instead of keeping him waiting if a delay is necessary. Keep paper, pencil and business records at hand. Say 'thank you for your inquiry' (or your order). And then above all else, fill his order with exactly as fine a quality of merchandise, or with as prompt and perfect service as if he had come to you in person." Hints

like those to department stores about selling by telephone, instead of simply taking orders, are also given.

Farmers find the telephone very useful and profitable for checking market shipments and prices before they decide when and where to send their produce, and their local paper gets the official market reports on vegetables and fruits, eggs and poultry, dairy products, livestock and hay, read over the telephone "pony circuit" from the Associated Press office every day.

Without the telephone our daily papers could not exist. Newsmen with their telephones reach out to a million inaccessible spots, scoop up the news and bring it to their own desks. By telephone from their office, they may interview an American notable on the high seas or an explorer emerging from the Brazilian jungle. By telephone, from the near or far places of the earth, where they are scattered to catch the possible piece of news which may blacken the front page today, they speed to their home offices the words and deeds of soldiers and statesmen, scientists and celebrities. The "desk" assigns a rewrite man who goes to one of the telephone booths ranged along the office wall and takes the story in notes. In almost as little time as it takes to tell, an "extra" may be on the streets.

Not many years has news traveled like this. The first newspaper dispatch ever sent by telephone was dictated over eighteen miles of wire between Salem, Massachusetts and Boston, in February, 1877. Since then, a new era in journalism has dawned. Only since 1915, you will remember, has it been possible to talk by telephone across the American continent and only since 1927, has there been regular overseas service. Service to Western Europe, from ship to shore, to South America and the Far East followed

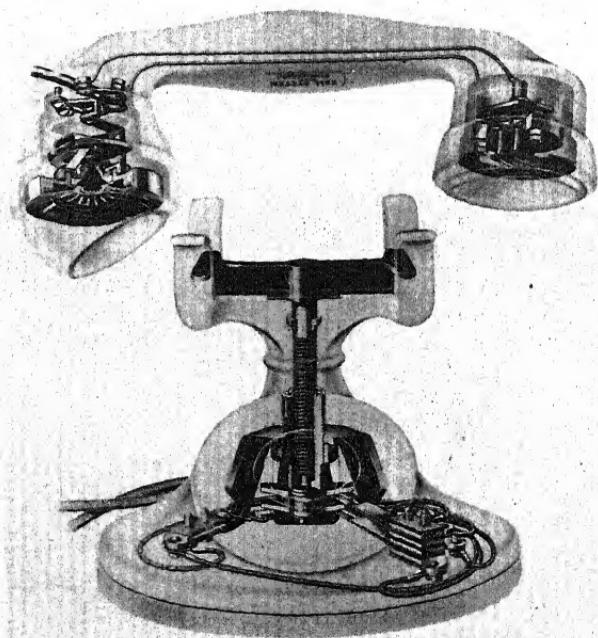
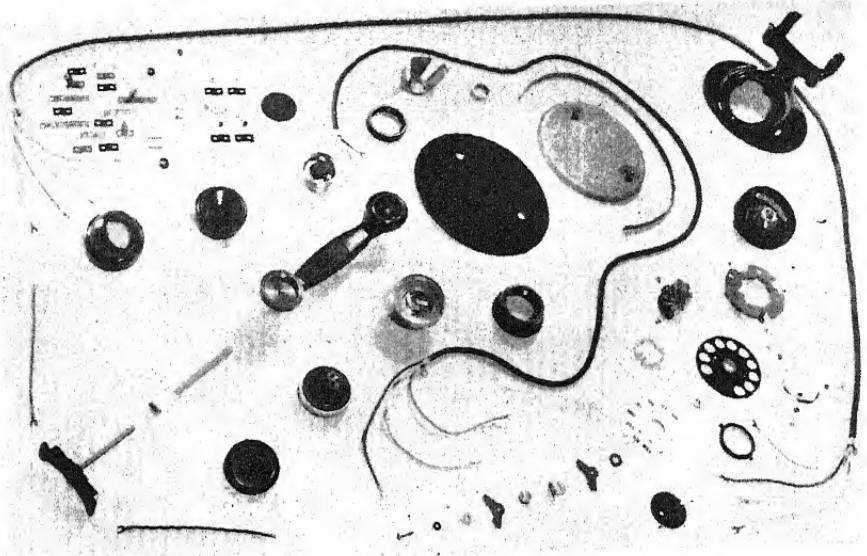
even later. Not until 1934 did it reach out to embrace Japan. In the meantime the teletypewriter, which transmits the written word from one electric typewriter to another, and telephotograph, by which photographs are sent over wires, were developed and adapted for the use of the press.

Constant improvements in telephone equipment and service have kept pace with ever-widening needs of the news industry. Particularly is this true in emergency situations. Whenever a big event is expected, which will bring crowds of newspapermen, special facilities are provided; extra trunks and switchboards; coin box telephones, mounted on trucks, roll right up to the scene of action, with tie lines connecting them to the nearest trunk line.

When the submarine *Squalus* sank, for example, in May 1939, an operator in Portsmouth, New Hampshire, surmising from the unusual number of calls from the Navy Yard that something must be wrong, asked if she should call in extra operators. By the time the three hundred newspapermen, broadcasters and photographers, assigned to cover the story, arrived, a special press room was set up with special facilities for telephoning, telegraphing, teletyping, broadcasting and transmitting photographs. One reporter had a telephone installed in his automobile and used that as his office. The telephone company's radio agent lined up all available radiotelephone equipped boats for reporters to hire, so that they could have telephone facilities at sea at the actual scene of the sinking. Though the disaster occurred in the ocean, out of sight of shore, as the result of a carefully worked out plan of cooperation between the Navy, Coast Guard, press, radio stations and telephone company, each step of rescuing the survivors was known



Train dispatching equipment, Pennsylvania Railroad



This dial telephone set is made up of 248 pieces

throughout the United States and the world, almost as soon as by men at the scene.

When something like a flood or hurricane disrupts telephone service, then suddenly we become keenly aware how essential the telephone is to our normal way of life. In such times of disaster, telephone service is often a matter of life or death for large numbers of people, and the most strenuous efforts are made to restore it as quickly as possible. Standardization of materials and practices greatly facilitates this. When half a million phones were silenced by the terrific hurricane, floods, tidal waves and fires which ravaged the North Atlantic States in September 1938, an army of 2500 telephone men and 600 supply laden trucks came rushing in from 21 states, some of them as far as a thousand miles or more away to aid the local force. Highways were blocked with twisted trees, poles and tangled wires; bridges which supported telephone cables were washed away, and debris piled high. To an ordinary subscriber the job looked almost hopeless, but the telephone men, no matter how far from home they were, knew what needed to be done and they did it—quick temporary repairs, first, to re-establish service for hospitals, police and fire departments and relief agencies—then thoroughgoing reconstruction. Twenty-two thousand new poles, seven hundred miles of cable, thousands of miles of drop wire and strand for guying up poles and suspending overhead cables, and thousands of tons of hardware, solder and other supplies were involved.

The motorized units and highly trained personnel, capable of handling an emergency such as this in times of peace, are so well coordinated that they can also serve the purposes of national defense at only a moment's notice, if the

need arises—an army of over 365,000 men and women and 21,500 motor vehicles.

The part the telephone plays in the routine government of a country like ours is also a vital one from the point of view of both the people and the authorities. The most remote citizen is as near to Washington as the nearest telephone: Washington has more telephones per hundred population than any other city in the world, and, on a typical busy day, makes nine thousand long distance calls. There are hundreds and hundreds of telephones in the buildings of every department and the Secretary of State has one on his desk, which affords him immediate contact not only with the White House, all other Departments, Congress and the country at large, but also with most of the foreign capitals of the world.⁷

Elections need no longer be held in November to give sufficient time for making known the results from the whole country before inauguration day. Returns are now known in every village in the land a few hours after the polls close.

American telephones are not limited chiefly to large cities; ranchers and farmers and small-town folk have their telephones the same as metropolites do, and one hundred and seventy circuits on four separate routes span the entire continent. A high ranking Army officer recently made the statement that with this telephone system and its accompanying network broadcasting facilities, the United States, if it were necessary, could be mobilized for war now in one tenth of the time required in 1917.

Most of the government's telephone service is of the everyday business and domestic variety, local calls between offices, long distance calls to reach public officials at home

or in transit. There are, however, unusual and interesting uses to which the telephone is put by some departments.

The Weather Bureau, upon whose regular forecasts so many and varied enterprises depend for advice in making their daily plans, uses the telephone together with the telegraph for collecting observations from all over the continental United States. Observations from outlying regions, foreign countries and from ships at sea are secured by radio. Forecasts are disseminated by telegraph, telephone, teletypewriter, radio and mail; years ago, though they were provided by the Department of Agriculture, the benefits that commerce and navigation derived from these forecasts far transcended those received by the farmer, because it was difficult to reach him with weather warnings in time to be helpful. The extension of rural telephone service changed this situation; and now, about three hundred broadcasting stations, connected by telephone networks and cooperating with the Weather Bureau, make official weather forecasts available to agricultural communities, no matter how remote, almost as soon as they are issued. There is an announced daily schedule for these, so that farmers know when to listen. Special warnings of cold waves, frosts, floods, storms, hurricanes and other severe weather conditions are given by telephone and teletype to interests likely to be affected.

In three different citrus fruit areas in Southern California, the growers themselves maintain a system of motorcycle or automobile "riders," who patrol the orchard districts on cold nights, reading thermometers and reporting by telephone to a central headquarters at frequent intervals. As the temperature falls to near the danger point in any given area, a special corps of telephone operators calls each indi-

vidual grower in that area, getting him out of bed with the warning that it is time to light his orchard heaters. In one of these orchard districts there are outlets on the telephone poles into which the "riders" can plug portable telephones for calling the central office. When dangerous temperatures are expected, the Weather Bureau advises telephone officials how many extra operators will be needed and at about what time.

All busy airports have leased teletype facilities for reports on sky and weather conditions, made at frequent intervals by the Department of Commerce.

As part of its flood control work, the Weather Bureau makes use of robot river-stage reporters. These devices are installed at points where it is extremely difficult to obtain the services of a person to make and report eye-readings of the river stage, or at points where it is important to obtain frequent reports at all hours of the day and night. They consist of a "stilling well" with a float resting on the surface of the water which makes contact with varying signals as it rises and falls, and transmits them by telephone. When the number of any one of these instruments is dialed, telephonic connection is automatically made, and any listener may hear the buzzer signals, the timing of which indicates how high the water is. During a recent flood in the Susquehanna River, the stage was obtained each hour from the robot at Harrisburg, Pennsylvania, and the public was informed of the steps to be taken to protect life and property.

Another branch of the Department of Agriculture to which the telephone is very important is the Forest Service. In forest fire control it plays a vital part, for, in this, speed of attack is absolutely essential. With rapidly spreading fires, if the suppression force is to arrive in time to prevent

enormous damage, not over fifteen minutes can be allowed for the functions of detection, report and get-away, after the fire starts. Lookouts are posted in high towers all through our forest regions, whose job it is to watch constantly for smoke. As soon as he sees a column rising, the lookout locates its direction from his observatory, in degrees and minutes, and telephones this information to the nearest ranger stations, where fire fighters are ready to rush out with the necessary equipment.⁸ Telephones are installed at regular intervals along the roads through forested areas with conspicuous signs reading, "Report fires here." The Forest Service has more than a thousand portable short-wave radio sets for reporting the progress of fire fighters, and communicating their needs in localities where no telephones are available.

The United States Coast Guard, which is a branch of the Treasury Department, reports through its public relations officer that "both the wire telephone and the radiotelephone are of inestimable value in maintaining official communication with many of the more important lighthouses and lightships. Telephones have, for years, also been a great comfort to the keepers, particularly at those lighthouses which are remotely located."

The public telephone with its succession of different users has been the subject of much attention and investigation on the part of public health authorities.⁹ Experience with millions of telephones used each day for many more millions of conversations, however, has failed to produce an authenticated case of disease transmission by the use of the telephone. Companies have been formed to visit telephone stations and disinfect them for a monthly fee, and various devices and preparations designed to make tele-

phones "antiseptic" or "sanitary" have been put on the market. Attempts have been made to agitate for legislation requiring the disinfection of phones, but because such measures were not at all necessary they have not received the support of the government agencies which guard our health.

Two special studies were made of hundreds of public telephones in Chicago and New York, in the course of which bacteriologists wiped transmitter mouthpieces with moistened sterile swabs, and then made cultures from them to determine the kinds of bacteria present. In both studies, certain disease-causing bacteria were found on some instruments, but nearly ninety per cent of these were of varieties that would be dead within fifteen minutes after deposit, and none of them could jump from their resting place into a talker's mouth.

To the police forces of our nation, the telephone is a particularly indispensable adjunct. Constantly, citizens are urged to report to headquarters without delay, not only crimes which are witnessed but also suspicious-seeming persons or circumstances. "Phone the police," posters say; the faster a report gets in to headquarters, the faster the police department can swing into action, thus cutting down "escape time" and making arrest more probable. The forces themselves, of course, use the telephone, local and long distance, for both spreading and collecting information and giving orders. They warn departments in other communities to be on the lookout for a bank robber or a stolen car of such and such description. They call the Motor Vehicle Bureau to find out who is the owner of a certain license. They have even developed a system whereby they can identify fingerprints over the telephone.

The call box for "the cop on the beat," which used to be the basic system of police communication still plays a minor part in the service, but with motorized criminals have come vastly improved communication facilities and techniques. The short-wave two-way radio and the teletypewriter, both telephone by-products, have revolutionized police practices. Within limited areas the two-way radios are proving to be of increasingly great value in keeping mobile police units, such as automobiles, in constant touch with headquarters, while over wide areas the teletypewriter with its printed record, its duplicate copies, its ability to receive messages at unattended stations, its secrecy and its power to communicate simultaneously with many points, offers additional features of very great value to law enforcement bodies. Traffic police also use the telephone and radio for advising week-end and holiday motorists of congested highways and alternate routes.

The tapping of telephone wires as a means of obtaining incriminating evidence has been the subject of much lively discussion. Diabolically clever devices have been invented for this purpose, but the United States Supreme Court has outlawed the use of such evidence in Federal Courts under existing statutes. Better let a few criminals go unconvicted, was their decision, than have the whole nation subject to the possible abuses of official wire tapping. A number of bills have been introduced to legalize wire tapping by regular police, "G-Men," Customs Officials, Coast Guards and Tax Collectors but so far none has been enacted. This does not mean, however, that the subject has been ignored by responsible authorities. The Federal Bureau of Investigation knows the science of wire tapping thoroughly, the Secret Service goes over the White House and its

grounds regularly for wire tapping devices; the Signal Corps guards the secrecy of Army communications; and the Navy Intelligence section, those of the Navy. When calls are made between high ranking officers of our State Department and the heads of other governments the full force of surveillance is always in play. On behalf of national defense in the present state of world affairs, however, Congress is likely to pass a bill to legalize wire tapping by the F.B.I., where espionage is suspected.

In related vein, telephone companies have been subjected to bitter criticism, both oral and editorial, and to legal prosecution for providing illegitimate enterprises with telephone service. A recent Pennsylvania statute set a penalty of from one to three years' imprisonment, or a fine of from one to five thousand dollars, on companies furnishing telephone wires or services for disseminating racing information. Telephone companies, in a way, welcome this sort of legislation because it simplifies their public relations. They are, of course, aware that a garage which orders a hundred private-wire phones installed on the second floor does not expect to derive its entire income from repairing and storing cars, but telephone companies generally are under duty to provide service without discrimination. According to the current rules of the game they cannot pick and choose their customers, or censor the conversations that go over their wires. Until officially proven guilty, the "bookie's" headquarters receive the same sort of telephone service as the stockbroker's office. That is part of our American way.

In May, 1916, United States Navy officials made their first tests of telephoning to ships at sea. Conversations were carried on between the naval radio station at Arling-

ton, Virginia, and the battleship, *New Hampshire*, fifty miles off the Virginia coast. Soon after the United States entered the war, in 1917, Bell System engineers had also devised methods and apparatus for telephoning to airplanes in flight. The first successful two-way communication between a ground station and a plane in flight was established at Langley Field, Virginia, in August of that year. When short-wave radiotelephony was introduced, mobile services began to be developed on a commercial basis. The first of these was the ship-to-shore service initiated on the North Atlantic, in 1929, by operation between the late S.S. *Leviathan* and transmitting and receiving stations in New Jersey. This made it possible for anyone to pick up a telephone in his home and, in just a few minutes, be speaking with someone aboard a liner in midocean; or vice versa, for world travelers to keep in touch with home from wherever they might be. At one time as many as twenty-five liners, on both the Atlantic and Pacific were equipped with this service, but since it was discontinued on ships belonging to belligerents, there remain on the Ship-to-Shore Operator's call board only our own S.S. *Washington*, S.S. *Manhattan* and S.S. *America* in the Atlantic and the *Kamakura Maru* in the Pacific.

Radiotelephone service is available, however, not only for luxury liners, but for the tugs and trawlers of our coastal waters as well.¹⁰ Today, more than two thousand different boats in the coastal and harbor waters of this country, as well as on the Great Lakes, can keep in touch with their headquarters or make a call to any telephone on shore. About half of these boats are yachts and pleasure craft and half are tugboats, barges, fishing-boats, steamships, ferry-boats, pilot-boats, and other commercial vessels.

Every day, people aboard these boats discuss with other people ashore, by telephone, such commonplace but important matters as are illustrated by the following fragments, fictitious but typical:

"Proceed to Pier 18 for immediate tow of barges A and B, which are loaded with cars of perishable fruit. Can you pick up these barges in an hour and have you enough coal aboard for a fifteen-mile trip?"

"Our engines have broken down one mile east of Execution Light. Can you send us a tow and also twenty feet of tube to repair fuel line?"

"Hello, Margaret. We had a pleasant trip and expect to land at the yacht club dock about seven o'clock. Please have a car at the dock to meet us. Will it be convenient to wait dinner for us?"

"Mr. Jones, this is your secretary speaking. We have advance information, that there will be considerable weakening in the market today and Mr. Smith has asked me to ascertain what action you wish taken."

"This is the trawler *Mary*. We have run into a large school of mackerel ten miles south-southeast of Montauk Point. Suggest you notify other company trawlers operating in this vicinity to proceed here."

Companies operating fleets of tugboats, lighters, barges or other vessels can use radiotelephone service to great advantage, as dispatching orders may be given or changed while the vessel is in operation, and help may be summoned when necessary. In this way they cut down on idle tug time and secure economy in operation. This is of vital importance to a towing company, for a more efficient use of tugs means a more profitable business, and fewer delays mean better service to the customer.

One of the yacht owners subscribing to this service, until he turned his yacht over to the Navy, was Major Edward Bowes of "amateur hour" fame. Not so long ago a sudden squall resulted in the crushing of one of the Major's fingers, by the closing of a heavy door aboard the yacht. The Major used his radiotelephone to call the switchboard operator at the Capitol Theatre in New York, asking her to have his chauffeur and doctor ready at the dock when he arrived.

To the thousands of Americans, especially in New England and Alaska, who depend upon fishing for their livelihood the radiotelephone has been a special boon. It means that the captain of a Boston trawler can keep in constant touch with the Fish Pier office, discussing his catch, market prices and conditions of crew and weather, before deciding to rush in with what he has, or stay out a few days longer. In Alaskan waters, not so much the fishing-boats themselves, but the tenders, which cover widely scattered sections collecting the daily catches of salmon from the fishing-boats, are equipped with radiotelephones. These keep in touch with their cannery superintendent at all times, and their movements are directed by him so that the supply of fish for the cannery is regular and continuous, and the approximate size of the day's catch is known, and prepared for at the cannery, before it arrives there.

The fact that radiotelephoning can be done by a person doing something else at the same time, and does not require a trained operator, makes it particularly adaptable for fliers. The Department of Commerce maintains a radiotelephone service for broadcasting to pilots, at scheduled intervals every hour or so, information concerning existing weather

conditions and forecasts for both general and local areas. On some air lines, two-way communication is maintained during flight, so that pilots may report their positions directly to dispatchers, and ask for supplementary data on local ceiling heights and conditions in the upper air strata. Most large air liners have, in addition to their facilities for two-way voice communication with landing fields, a little telephone system connecting the pilot, co-pilot, flight engineer and stewardess, so that they need not run back and forth and shout to each other. When the ship lands at an airport, these phones may be plugged into the nation-wide wire network and passengers may make calls to any place desired.

New York City now has a police force in the air as well as on land and water. This newly organized arm of the law consists of two high-powered planes, one a land plane and the other a seaplane, both radiotelephone equipped. By their two-way radio voice links, the planes while aloft may keep in close touch with all other divisions of the department. They may talk directly with the two-way radio patrol cars on the ground, and similarly communicate with police patrol boats covering the waters about the city.

These sky police are particularly useful in automobile traffic control, and searches for wrecks or persons afloat in need of aid. Their planes are designed for conversion to ambulance use, and may also be used in aerial photographic work for the city's law-enforcing agencies.

Mayor La Guardia of New York City has even his own car equipped with a two-way radiotelephone. En route to the City Hall, he can pick it up and announce, "This is Car N Y C, the Mayor speaking. Connect me with Com-

missioner So-and-So of San Francisco," and soon he'll be talking with that official. Before the war, a nation-wide audience listened in and heard the Mayor, while driving through Central Park, use his new telephone for a chat with the Lord Mayor of London, riding in his horse-drawn coach. This N.B.C. broadcast was made possible by trans-atlantic telephone and a special radio hookup with the British gentleman's vehicle.

The New York Mayor is said to be the only chief executive with such up-to-date communication equipment. It is a part of the local Fire Department's radiotelephone system, which in addition to connecting the Mayor's car with the city-wide and nation-wide telephone system, serves the cars of the Fire Commission and the Fire Chief. Officials state that this system is a great aid to supervision in fire fighting, for it enables one to get information even as he rushes to the scene and, if necessary, to give immediate orders for additional men and equipment.

Most railroad systems in America, also, have their system of telephone lines. From one station to another or to a group of stations, telephone dispatching systems, because they require less time, less training and less physical and mental strain, have replaced the telegraph as a means for signaling and talking on sixty-five per cent of the railway mileage. Between stations, portable telephones—which can send a signal over 400 miles of ordinary open wire—may be connected to the lines. Wrecking trains, handcars, and freight as well as passenger trains, are being equipped so that they may communicate with headquarters whenever desirable.

The telephone is especially valuable in cases of emergency

because any member of the train crew can telephone the dispatcher the necessary information. If a cloudburst has washed earth and stone from a steep hill onto the tracks, the engineer can bring the train to a stop, the brakemen raise a long rod to the overhead wires of the railroad's telephone system, clamp down the contact arms, and hook up the portable phone to report the condition to the next station and ask for further orders.

On the great royal-blue and silver train of the Canadian National Railroad which was the home of King George and Queen Elizabeth while they were visiting this country in 1939, was a complete telephone system. When the King wished to confer with a member of his party nine cars ahead, he simply lifted his gold-finished handset of latest bell-in-base design and talked. Almost every day the Queen talked with the little princesses in London by transatlantic radiotelephone right from the train, when it made a scheduled stop.

When our President travels by train, also, telephone men are waiting at every stop to connect his car by special long distance circuits to the White House. In some foreign countries, before the war, radiotelephone service was provided for passengers on extra-fare express trains. Some twenty-five years ago, in this country, telephone facilities were provided, experimentally, for fast-moving trains, but the demand has never seemed to warrant providing them on a commercial basis. Our "crack" trains, however, are equipped with telephones which may be plugged into the nation-wide telephone network as soon as they stop at stations.

The very large buildings and the skyscrapers for which American cities are famous would be inoperable without

the telephone. Many hotels, office buildings, large stores and hospitals require telephone systems and staffs comparable to those in fair-sized towns. Some of them present rather interesting features. In large hotels, for example, most of the contacts between the guest and the management are by telephone; the guest has come to regard the telephone as a means of getting what he wants in a hurry and if the management is to convey effectively its eagerness to make his stay pleasant and comfortable, good telephone service is essential. This means not only that the voice which answers the guest's call must "wear a smile," but also that there must be adequate communication facilities with all service departments, so that orders for the room boy, the restaurant, or the housekeeper, may be promptly fulfilled. It means that all the guests' incoming and outgoing calls must be quickly and accurately handled, and that the management must be able to make contact with any department at all times. The foreign diplomats, attending an international conference, will require a different type of telephone service from the newsboy's or woman's club convention delegates; the staff must be prepared for all kinds.

The *Waldorf-Astoria* which occupies an entire block in New York City is rather proud of its communication service. A network of teletypewriters throughout the enormous building makes it possible for the room clerk, the bookkeeper, the floor clerk and the housekeeper to know all the details of your registration as soon as you leave the desk; and when the elevator door opens at your floor, someone is there to greet you and call you by name, while showing you to your room. All members of the staff, who are to assist you or be influenced by your departure, are similarly notified when you are ready to leave, and each

steps up to do his part in proper sequence. A special information service, the "About the City Bureau" is also maintained to answer guests' questions by telephone.

The *Stevens* in Chicago, said to be the world's largest hotel, uses the P-A-X Automatic Interior Telephone System for supervising and directing its 1500 employees in their daily routine of keeping 3000 rooms spick and span, serving 5000 meals, and creating a favorable impression on its many guests. This system is also used by the management in New York's "city within a city," Rockefeller Center. Four hundred P-A-X phones provide its engineers, renting and purchasing agents, operating superintendents and such, with instant telephone access to important points in eleven buildings—to warehouses, elevators, machine shops, boiler rooms, etc. This system is a product of the company started by the Kansas City undertaker, Strowger, whose automatic system was mentioned in Chapter II; it may be used for any number of private phones from five to ten thousand. The instruments and necessary operating equipment are bought outright; they are not subscribed for like the city and nation-wide telephone service which they supplement, and they do not require the attendance of an operator. The fact that connections are made automatically and are locked against intrusion, appeals to many executives who like to feel sure that their conversations and orders cannot be divulged and discussed by subordinates. The way it makes possible the carrying on of internal business without tying up outside calls appeals to others.

The hospitals' facilities are somewhat similar to those of the hotels in the matter of telephones. One distinctive feature about their service is the "soft speaker" system

which links every ward, so that when a particular doctor is wanted in an emergency, the attendant's call for him may go simultaneously to all sections of the building without causing any disturbance to patients.

In becoming a great American institution, the telephone has developed two aspects which the average subscriber is apt to think little about, the legal and the esthetic. With relatively little fanfare, there have grown up, through the years, a monumental number of regulations and rulings, by various state commissions and courts, to determine the responsibilities and liabilities which the telephone companies have to the public in the operation of their properties. These vary in different states and are subject to constant revision. The American Telephone and Telegraph Company retains what has been called the most able legal department in the country for keeping itself and its operating companies straight with respect to existing law and for warding off possible difficulties. Skipping through an alphabetical list of rulings pertaining to the telephone, one finds such headings as "Abandonment of Territory. . . Coin Box Service, Right of Company to Require Use of. . . Depots, Telephone in. . . Directory Binders. . . Eminent Domain. . . Fraudulent Use of Service. . . Gambling, Refusal of Service. . . Highways, Poles along. . . Liability for Highway Accidents. . . Moving Underground Plant. . . Pay Station Theft. . . Profanity. . . Rates, Discrimination in. . . Right of Way. . . Taxation. . . Toll Overcharges. . . Tree Trimming. . . Wire Tapping."

While the big rate cases against the telephone companies are the ones the public hears most about, minor suits of various sorts are also brought from time to time; a business

subscriber's name is listed incorrectly and he sues for the losses he claims to have suffered as a result; an advertiser sues because a binder is put over the back page advertisement he paid for; an operator sues a subscriber for using foul language to her; a storekeeper thinks it was because of the telephone wires that his shop was struck by lightning, and brings suit. A prize case was that brought recently against an independent company by a southern farmer whose mule had been standing near a telephone pole and got his tail twisted around a guy wire. The mule became excited and pulled away minus the tail. Since a tailless mule cannot swish flies, he is good for nothing, and the owner sued the telephone company for a replacement. Incidentally, for the sake of their public relations, they gave him a new, fully equipped mule.

The training in safe practices and first aid, which tens of thousands of telephone employees have received, is also important in connection with the companies' public relations. Not only does this develop habits of working and everyday conduct that prevent linemen and installers from making themselves a nuisance or a hazard, but it guards against the occurrence of accidents, too, and puts into active circulation a great number of men and women capable of rendering vital assistance in the places where accidents happen.

In memory of Theodore N. Vail, who played such a prominent role in putting the telephone into the big business class, a fund and system of awards for noteworthy public service was established in 1920. Over a thousand men and women of Independent as well as of Bell companies, have been cited for the rescues which they have accomplished individually or in part by their alertness and

intelligent "service beyond the line of duty." Here are a few of their stories:

As two telephone men of Independence, Kansas, were preparing for a toll line inspection trip early one morning, the roar of an airplane motor, unusually close, attracted their attention. They saw a large tri-motor plane flying very low over the town, at a rate of speed well below normal and with a very definite list. After covering only a few miles of their trip, they spied the wreckage of the plane in a freshly plowed field, left their car, and hurried to the wreck. The pilot was dead, the remaining thirteen people aboard the plane all seriously injured. One telephone man asked his fellow worker to call ambulances and doctors, and himself organized a rescue squad, and directed the removal of the injured. He warned onlookers to stop smoking, since the wreck, the passengers, even the rescuers were soaked with gasoline. When the only ambulance available could carry but three of the injured, he quickly arranged for the others to be taken to the hospital in private cars, and assisted in placing them in the cars. He aided the small hospital staff in caring for the injured, and telephoned for a physician and nurses from neighboring towns. His treatment of the injured was so efficient that he was credited with a substantial part in the saving of many lives.

In a mine near Miami, Oklahoma, a cage dropped sixty feet, killing one man and injuring two others. Because of his known competence in first aid work, a telephone repairman working near by was asked to go down another shaft with two miners to care for the injured. He made a perilous journey along an abandoned underground route to reach them, controlled their bleeding with materials available, cared for their other serious injuries, and supervised their removal on improvised stretchers. As a result of this telephone man's competent and effective work, one of the injured miners recovered.

An operator, who had been informed of a bank holdup, checked the path of the gangsters' escape by telephoning farmers along various roads; and, by keeping the police cars in-

formed, helped to bring about the capture of several public enemies.

Some children were playing with the electric trains under a Christmas tree in the lobby of a hotel in Jersey City, New Jersey. A short circuit caused a spark which ignited the artificial snow and the fire spread to the dry branches. In a flash, flames and smoke filled the room. The private switchboard operator, just as quickly began calling all the guests, one after another, to warn them of the danger. Not until she thought she had covered every occupied room, and was almost overcome by the heat and smoke, did she leave her position, and then it was too late. All the guests, except one of the children, were saved, but the telephone operator died of her burns.

The average subscriber may not have thought very much about the esthetic aspects of the telephone in the United States today, but recollection of the older types of instruments, booths and buildings in comparison with those of current design, indicates clearly a trend of respect for appearances and a developing taste. Though not ornamental by any means, the new handsets are honest and functional in design, and by special arrangement may be had in any one of twelve colors. Booths and public telephone stations, as well as telephone company buildings, are designed to conform to their function and surroundings. They look neat, efficient and not too conspicuous. In residential districts and small towns, the telephone exchange is housed in a residence type of structure set back from the street with a lawn. In business sections, the telephone building is usually one to which citizens point with pride. Directory covers are being designed more and more with an eye to appearance instead of advertising revenues. Poles, where possible, are set with regard to the landscape, and linemen are trained in scientific tree-trimming, so that they may

make overhead wires safe, without marring natural surroundings any more than is absolutely necessary.

All of this, and more, is involved in our telephone service, and yet we take it so much for granted, that no one ever thinks as he lifts the receiver and asks for a number on the other side of town, "I am asking in effect, 'Give me the use of several miles of wire in a cable under the street, a section of switchboard and all the other equipment needed in the central office. Give me one kind of current to carry my voice and another to ring the bells that signal the other party. I may need the services of an operator or two. I want all your equipment to be in perfect working order so that my call goes through instantly, clearly and without interruption. And — oh, yes, don't charge me any more than a nickel.''"



No Emergency May Stay the Words of Men

CHAPTER V

TELEPHONE OPERATORS

THE FIRST TELEPHONE OPERATORS, LIKE THE IRON-WIRE lines and the earliest switchboards, were a carry-over from the telegraph.¹ They were boys, some not more than thirteen years old. While many undoubtedly took their duties seriously and tried to do their best, not a few of them, it seems, had the job thrust upon them by distraught mothers who hoped that it might keep them out of mischief. From some reminiscent accounts, however, it would appear that the telephone office only afforded greater facilities for causing annoyance; several of these boy operators, who grew up with the telephone business, recall how they yelled at each other, whittled on the boards, leaped pell-mell between switches—not, of course, with the idea of expediting service, but for the sheer fun of it, and if they could knock over a couple of fellow operators in the process, so much the funnier. When some other diversion held their attention, they would leave a call unanswered for any length of time, and then return the impatient subscriber's profanity with a few original oaths.

Though it is not likely that such goings-on were tolerated continually, the first operators were "not old enough to be talked to like men, and not young enough to be spanked like children," and, until better methods were devised for the operation of telephone exchanges, they were kept on, and performed a variety of functions. Often, in

addition to finding which one of many close-set like-sounding bells was ringing, and to making the desired connections, the job consisted of sweeping the office, keeping coal on the fire and carrying out the ashes, running errands, collecting bills, throwing wagon spokes at line wires when they became "crossed" by the wind, and shouting through the window to the hackman on the street that Mr. So-and-So had called for him to meet the eleven-thirty train—all for five dollars a week.

The idea of trying girls as operators seems to have dawned on two managers almost simultaneously. The New England Bell Telephone Company claims the title, First Female Telephone Operator, for Miss Emma Nutt, while the New York Telephone Company upholds, for this honor, Miss Margaret Kennedy.

In the late 'seventies, many people thought that it was not quite decent for young girls to go outside of their homes for employment; it jeopardized their chances of marriage. Though the typewriter, with the same essential features as today's, appeared at about the same time as the telephone, it did not come into general use until the 'nineties when the touch system began to be taught, and even then "respectable" parents did not approve of their daughters becoming typists and spending their days in offices with men. Some thought it less compromising to serve as clerks in shops or dry goods stores (there were no department stores in those days), but this, on the other hand, thrust a girl into contact with people of all sorts, and one could make no secret of the fact that she was working.

The desire to earn some money which she could call her own and spend as she pleased, however, lured many a girl to seek remunerative employment, and there were

many who found it necessary to earn their own living or to help with their family's finances. For these, telephone operating was an interesting alternative to clerking, factory work, dressmaking and millinery, or nursing, a profession which had only recently become dignified and popular, thanks to Florence Nightingale and Clara Barton, and their application of the newly recognized principles of hygiene and sanitation. Among the early telephone operators were girls who had had experience also as cashiers, copyists, bookkeepers and clerical workers. The usual grammar school education appears to have been sufficient for any of these jobs. Little thought was given to educational qualifications. Public high schools had developed rapidly in the United States after the Civil War, but it was by no means customary for girls to continue their education this far, unless they meant to become teachers or to enter one of the professions newly opened to them.

It was difficult at first to get girls for telephone operators. Office managers occasionally went into the home of a gentle soft-voiced girl who they knew would be an improvement over a boy operator, and pleaded with the parents to let their daughter take the job. Friends quickly recommended friends, however, and since the work they offered was steady, under more pleasant conditions and for shorter hours than the factory, less fatiguing and more secluded than the store, and fascinating because of its novelty and possible future, telephone companies soon found themselves with long waiting lists of girl applicants. On such a list, "one might remain for one or two years," a pioneer operator wrote, "unless powerful aldermanic influence intervened."

Employment offices or departments, as separate entities,

did not come into being much before 1900, and there was no uniformity or formality in the steps to be taken in applying for a job or being hired. Some employers would not take a girl unless her father was dead and she had to support herself. Others would hire no widows, grass widows, sisters, married women, or women from out of town. Some required the recommendation of a minister and family physician. This was true among telephone office managers as well as elsewhere.

One young girl from Bayonne, New Jersey, journeyed by horsecar and ferry across the Hudson River, and arrived at a New York telephone office before nine o'clock in the morning, to tell the Traffic Superintendent how much she wanted to be an operator, how her friend was an operator, and how sure she was that she would like operating too. The Traffic Superintendent told her he would send for her if she were needed. "You won't forget, will you?" she inquired eagerly. "No, I won't forget," he replied.

Organized training or instruction for new operators was unheard of in those days. They received some help from more experienced hands, and the rest came with time and practice. In a small office, the new operator sometimes stopped by on Saturday evening to have a friend show her how to work the board at which she was to start on Monday morning. In busy offices, it was rather the custom to seat the new operators beside more experienced girls, and let them learn by watching. After a day or two of looking on, supplemented by such verbal instructions as the older operators could give them, the novices were allowed to handle calls themselves, during slack periods, until they became proficient enough for full-time operating.

With such hit or miss preparation, girls often got misconceived notions; not infrequently they referred to a "tone test" as a "tongue test," a "trunk" as a "trump," or to a "circuit key" as a "circus key."

Calls were usually made by name, until an office had about a thousand subscribers, then numbers were introduced. This usually met with violent protest on the part of subscribers who disliked bothering to look up numbers. "It seemed as if the public went suddenly blind," one operator said. For this reason, many especially conscientious and obliging operators spent their spare time studying the new directories, and memorizing numbers. There were no standard vocabularies until along in the 'nineties. An operator might answer a subscriber's signal with "Hello. Number? What is it please? What number do you want? or even What?" depending on her mood. Sometimes she would say "thank you" or repeat the number, sometimes she made the desired connection without saying anything.

"Our training," narrates an operator who began work at a switchboard in Chicago, in 1883, "was brief, and was about as follows: 'This is the switchboard ; this is a plug ; and this is a jack. When a drop falls, you will plug into the jack directly under the drop and speak into this part of the telephone—it is called the transmitter. You will put this part to your ear—it is called the receiver. You will give your number, which is thirty-six, and the subscriber will give you either the name or number of the party he wants. If he gives you the name, look the number up in the directory, write both numbers on one of these tickets, and pass it to the operator directly behind you, who will complete the connection.' Unfortunately for me, the tone of voice to use was not mentioned, and

there was no doubt a startled subscriber when, thinking to facilitate his hearing at such a distance, I yelled my number loudly. Promptly the manager advised me to hang my head out of the window: 'the subscriber will hear you better, and it will be more quiet in the office.'"

The routine of operators answering with their own number is said to have been introduced for the purpose of discouraging "date-makers." "A good manner and a soothing voice," one of them related, "was our only protection against irate and profane customers who had become accustomed to swearing both at and with the boy operators." When a doctor subscriber dropped into a New England office, and explained to the operator that he was apt to swear occasionally but that he would not mean it, she promptly replied that she could stand nothing stronger than "damn."

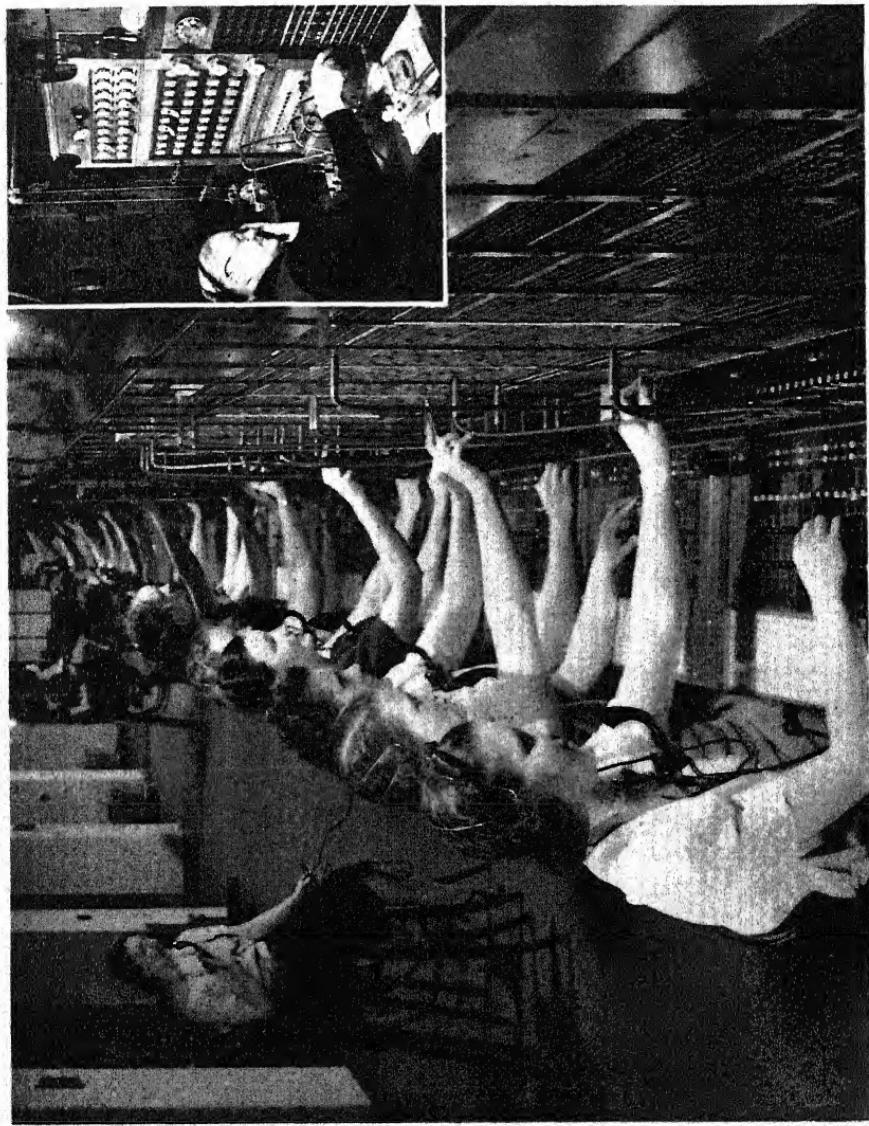
Though many of these pioneer girl operators were still in their teens, and most of them had neither seen nor used a telephone before, it was soon generally conceded that their service was much superior to that of the boys. True, they were often fond of "airing their voices," and wasted some time talking with subscribers, but on the average they handled their calls more promptly and pleasantly than the boys and it was said, "are steadier, do not drink beer and are always on hand."

They did not, however, replace the boy operators at once. The transition took place slowly. Since most girls were allowed by their parents to work only during the daytime, boys were kept on the night shift, generally, in the United States, until after 1900. For several years, after girls were introduced as operators to preside over the boards where calling subscribers' signals dropped, boys continued

to be employed to connect the calling lines with the trunk line to the office called. These switch-boys usually gave the most attention to the girls whom they liked, or the ones who yelled the loudest. If a boy liked an operator, he put up her connection right away; if not, he might stand and grin at her, and she could shout until she was hoarse, and then resort to the manager. The manager sometimes disciplined an especially obstreperous switch-boy by making him stand in a corner until he was ready to apologize; but the corner often seemed preferable to the switchboard, and the spirit of repentance, overcome with inertia. Years later, however, when men, who in their youth had been boy operators, were asked what they had thought, at the time, about the girls taking their places, they replied, with perhaps better manners than memories, "We liked them; it was the best step the company ever took."

Sunday work was another problem,² fifty years ago. Sadie Means, for example, an operator at Columbia, South Carolina, had always been a good church member and regular attendant at church services, until her job demanded that she work on the Sabbath. Fellow members of the congregation with which Sadie had worshipped were thoroughly incensed by her unorthodox conduct and carried the case to a General Assembly of the denomination. After long and serious debate by the brethren, and a vote of forty-eight to fifteen, Sadie was finally vindicated, on the ground that maintaining telephone service on Sunday, in the event of accidents, illness or other disasters, was really an act of mercy.

Since the telephones were still used almost entirely for business rather than social purposes, very few calls went



Long distance "inward" switchboard at New York. Inset: A Swiss rural operator



1879



1878



1879



1880



1880



1888



1892



1900



Changing fashions for operators

through an exchange on Sunday, and, for that reason, it was thought no more than fair that operators should work a much longer shift (or in telephone parlance "tour" or "trick") on Sundays than on business days. There was no general practice, in these early days, concerning pay for Sunday work—sometimes extra pay was given, sometimes the operators were given another day off. Many parents, for religious reasons, would not allow their daughters to work on Sundays at all. In such cases the manager himself tended the exchange on the Sabbath, or the girl hired another, of less devout descent, to substitute for her.

The operator's costume in the majority of offices was an entirely personal matter, but a few managers insisted on uniforms, of black skirts and white shirtwaists in warm weather, replaced by black shirtwaists in winter. Later, in some offices, black dresses with white collars and cuffs and white aprons were uniform. It is recorded that in the days of high black buttoned shoes, one operator was reprimanded for appearing for work in a modish new pair of tan slippers. Bracelets and excess furbelows, which interfered with operating, frequently were forbidden; in one office bows in the hair were forbidden also. A pioneer operator in Paterson, New Jersey, recalls how in bad snowstorms she used to wrap her legs in newspapers tied on with twine and carry a broom to make her way to the office.

In the earliest days there were no telephone company buildings; a switchboard and an operator were tucked away in the corner of an office, the back room of a general store, an attic, loft, or railroad station, and there was a telephone exchange.³ A manager's desk equipped with listening-in apparatus, and a couple of chairs for visitors,

sometimes accompanied the switchboard at a discreet distance. A public telephone was often there too. Oil lamps, or gas burners supplied the illumination, and small wood or coal stoves, the heat in winter. Operators, as often as not, hung their wraps and washed their hands "somewhere behind the switchboard," and ate the lunch which they brought from home "over by the window." If any "fixing up" was done, the girls usually did it themselves; some of them put up hanging ferns and curtains for their own satisfaction; dusting and cleaning was part of their job, and they also had to devote some time occasionally to keeping mice, or pigeons, or waterbugs, from interfering with the working of the switchboard. During thunderstorms the switchboards would be alive with sparks; then, as one operator recalled, "we would go out in the hall and sing." One by one in some offices were introduced: gas plates, where water could be heated for a cup of tea; some dishes, brought from home; a cot, to be used by the night operator; and an arm or rocking chair, in which one could sit and do fancywork or read during dull periods. Employers generally had not yet come to think it their duty, or to their interest, to provide for the comfort and health of their employees; that was, in telephone offices as everywhere else, the employees' own concern.

Operators' wages varied from one company to another, according to the section of the country, and even within a single company. In general, they were higher in the larger offices and in the North, lower in small communities and in the South. In accordance with the amount of work they did, and where they did it, and the number of years of service they had to their credit, girl operators earned anywhere from six to forty dollars a month. The salaries

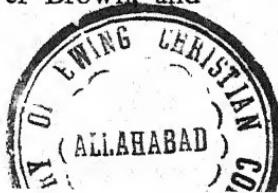
of telephone employees have usually been considered rather good for the given time and place.⁴

In addition to the wages paid them by the companies, girl operators used to receive substantial presents from subscribers, in the days before multiple switchboards were introduced. Then it was customary for each operator to attend regularly to the group of subscribers on her particular board, and she came to know their voices and telephone habits well.

Mr. Waters, who ran the coal and ice business and stuttered, cranked his bell to signal his operator regularly every morning and asked, "A-a-a-Annie, g-g-get me tu-tu-two wa-wa-one fu-fu-four."

And Annie would reply, "Yes, Mr. Waters, and shall I call the others too?"

Then, one by one, without his asking for the numbers, she connected him with the butcher, the confectioner, the freight yard and the lunch room. Mrs. Smith often called about eleven o'clock and said Bill had gone up to So-and-So's place, and would Annie please find him and ask him to bring some hamburg steak home for dinner. Lawyer Brown called Annie whenever he was leaving his office for an hour or so and asked her to make a note of any calls for him. Operators also gave their subscribers news of fires and accidents, sporting events and elections; they rang a subscriber's bell to waken him at the time he requested, or listened for the cry of the baby, left sleeping by the telephone with the receiver dangling, while its mother ran over to a neighbor's. Personal services such as these were rewarded by Mr. Waters with a daily delivery of ice during the summer, an occasional cake or pie from Mrs. Smith, a gift of money at Christmas from Lawyer Brown, and



such other miscellaneous gifts as a bunch of bananas from the fruit dealer, free tickets from the theatre manager, sausages from the butcher, and turkeys at Thanksgiving, cases of "tonic," and ice cream, in hot weather, from prominent businessmen, a sleigh ride from the liveryman, or—rare privilege indeed—a ride in one of the very first "horseless carriages." One especially favored operator reported having received, one Christmas, a hundred and twenty dollars, with candy, fruit and handkerchiefs besides.

In many small communities and rural sections of the United States, the years have made very few changes in the telephone operator's life. In many places, still, her switchboard is set up in back of the general store, or in a corner of the farmhouse parlor, and from there she continues to render the same sort of personal service. She is not on duty at night, for farmers retire early, but an emergency signal may summon someone if help is urgently needed to care for a sick person or to fight a fire. Independent telephone companies often contract with one woman to have operators on hand as needed. When they rent space for a switchboard in a farmer's house, it is usually with the stipulation that whichever member of the family happens to be nearest when a bell rings, will perform the functions of operator.⁵ Where such conditions prevail, there are several, sometimes many, subscribers on a line, and more than likely their telephone sets are of the old hand-ringing type. Some lines of this sort in rural districts are so arranged that no operator is needed; when Mrs. Smith wants to talk with her neighbor, she simply rings twice and Mrs. Jones answers. Mrs. Brown, whose ring is three, may also pick up her receiver and listen to their conversation. If it is near the hour, the metallic strike of

mantel clocks often proclaims a number of receivers off the hook.

As technical improvements were made in the telephone, and it became more convenient to use, its popularity increased greatly. Making a call no longer took a heavy toll of nervous energy, but was actually a comfortable and efficient means of communication. People began to feel that a telephone was the thing to have. In the cities, lists of subscribers grew to several hundred pages, and the average number of calls per day soared. More complex apparatus became necessary to handle the growing business. New buildings began to appear — two or three stories high, with stores on the street floor, and, above, specially designed accommodations for telephone offices and headquarters. "Goo-goo eyes" switchboards were introduced with blinking lights instead of metal drops for signals. Automatic time recording devices, called calculographs, began to replace the wall clocks and the Waltham watches for timing messages and toll calls. Information desks were established. Business methods and operating practices began to be systematized. Operators no longer had to make test calls every morning to every subscriber to say, "Good morning, this is the daily test. How do you hear me this morning?" There was little opportunity now for exchange of gossip and pleasantries between operator and subscriber; their relations became more formal and impersonal.

"Operating Rules" were issued which the girls were expected to learn almost by heart. Chief operators and supervisors were introduced to assist them in their work and to continue their training. In 1902, the first operators' training school was established in New York and was soon

followed by others in large cities, where various training courses were given and practice switchboards were used, so that the girls might gain some confidence and facility in operation, before they began to handle calls on central office switchboards.⁶

Along with these other innovations came greatly improved working conditions for the operators. Around 1900, the management of many companies began to show more consideration for the well-being and comfort of their employees. At first, free lunches or bread and butter, fruit and hot tea, coffee or cocoa were provided; then special lunch rooms began to appear. A decade later, cafeterias became popular. The individual telephone set, with receiver fitted over the operator's head and the transmitter, into which she could speak directly, suspended on her chest replaced the old type, hanging from the switchboard.

In some exchanges, rest rooms and dressing rooms were set aside for the operators. These were often supplied with tubs, hot water and fresh towels. A New England company permitted its operators to take half an hour every Saturday evening for upholding the tradition of the bath. Matrons or, in some places, trained nurses, were employed to look after the girls' comfort, and in their spare time to hem towels, make chair covers, black sateen aprons and half sleeves to protect the cuffs of the operators' dresses. Physical examinations began to be required for employees, but for many years no fixed policy in regard to illness was established. Sometimes the days of absence for illness were deducted from vacation allowances, and sometimes salary deductions were made. Other operators usually assumed extra work to make up for one who was ill. In 1913, throughout the Bell System, a uniform Benefit Plan was

introduced which granted each employee full salary for a certain period of illness, dependent to some extent on his or her length of service in the company. Pensions and death benefits were also provided for in this plan, because it was felt that employees could and would work better if they were afforded a sense of security by their employers. Soon after the Benefit Plan became effective, medical departments were also established in the larger offices, where employees could obtain remedies for minor ailments, and prompt attention in case of sudden illness or accident.

The moral health of employees was also guarded by the management of some companies; rules were published prohibiting the use of profanity or intoxicating drinks. Furthermore, according to one of these rules: "Cigarette smoking is strictly forbidden. No man or boy is to be permitted to remain on the company's payroll who uses cigarettes. The only exception to this rule is the negro employees." It seems that the possibility of girl operators smoking did not even enter the minds of these early telephone company Solons.

Gradually, through more than half a century, telephone operators, by their courteous and faithful service, won the respect of the public in many parts of the world. Soviet operators "in accord with the dignity of useful occupation due those employed in this industry," had to be addressed as "comrade" or "citizeness." Two Japanese operators, for their remarkable proficiency at the switchboard during a period of over thirty years, were honored with The Order of the Sacred Treasure, conferred on them by the Emperor. Several American operators had shown real heroism in various emergencies.

But as the use of the telephone continued to increase,

it began to be apparent that the manually operated switchboards would someday have to be replaced by automatic equipment. Because it was the latest and most efficient kind when telephone facilities began to be expanded abroad, much automatic equipment had been installed in various foreign cities, and its superiority in both speed and accuracy, as well as economy, had already been demonstrated. When our period of unprecedented prosperity in the 'twenties, therefore, created a demand for telephone service that it was almost humanly impossible to meet, dials and mechanical switching devices began to do some of the operators' work. Dials, of course, could never replace the girl operators entirely, because they could not complete complicated long distance calls, supply new or changed numbers at information bureaus, or assist customers who needed personal help, but they did make it possible for the same number of operators to handle greatly increased calling traffic, and they did preclude the large scale recruiting of new operators which was previously necessary in boom times.

On this technological development, Miss Frances Perkins, President Roosevelt's Secretary of Labor, wrote in her *People at Work*:

Of the hundreds of occupations in which women are listed in the Census of Occupations, only about a dozen employ more women than do the telephone companies. The human problem of the displaced worker when the cut-over was made from the manual to the dial system telephone exchanges is an almost perfect example of technological change made with a minimum of disaster. It was accomplished through human as well as technical planning. The company had owned the patent for automatic signalling, which greatly reduced the number of girls held on central duty, for many years, but it did not put

this technological improvement into operation until we were in the height of our prosperity and telephone extension was going on at a rate which had not been anticipated. So many more telephones were being installed, that they could put the automatic device into effect at the same time that they were hiring more people than they had ever hired before. The change to the dial system was begun in 1920, and the conversion was carried on gradually through several years. Hardship resulting to the worker through technological changes can almost be measured by the suddenness with which the changes are made. There was no serious dislocation when the labor-saving equipment of the telephone company was installed.⁷

The hiring of operators nowadays is a more formal procedure than it was in the early days of the telephone business. Throughout the Bell System, there are standard forms for applications and visitor's reports which have to be filled in with information concerning the educational and home background of the job seeker; and in several of the independent companies, similar routines are followed. In New York City for example, to be eligible for employment as an operator, a girl must have satisfactorily passed a physical examination—she should preferably live with her family and within one hour of traveling time from her office. She should have no major causes of friction or strain in her private life, and her family should realize that she is to render a public service and, therefore, is subject to duty at any time. She need not be a high school graduate but her penmanship, spelling and arithmetic must be good. She must also be amicable, sociable and have a pleasant voice, with no outstanding peculiarities of dialect or pronunciation.

Curiously enough, for a vocation which employs more

than 150,000 women, no aptitude test has been adopted for applicants. Chief operators seem to be able to tell a good prospect better by talking with her across a desk than by adding up her score on a formal psychological basis. Intelligence tests used to be given, and applicants with the highest I.Q. hired—but it was soon found that these did not make the best operators; they found it difficult and disagreeable to concentrate continually, and conform consistently to such a completely prescribed and highly systematized job. Left-handed girls may become long distance, but not local, operators. Though the spelling requirements for long distance operators, are more rigid than for local operators, strange as it seems, a long distance operator does not have to know anything about geography; she looks up places in alphabetical lists, not on maps.

The formal training of a Bell System telephone operator takes from three to six weeks. In addition to the handling of a switchboard, the new operator has to learn many other things; how to give positive satisfaction to customers,⁸ good voice habits, how to keep well, the importance of regarding all conversations as confidential, and how to "carry on" in time of emergency.

Since she is the representative of the company most frequently in contact with the public, it is important that she exemplify to the customer her employers' ideals of service, courtesy, accuracy and speed, and it is with her voice, chiefly, that she must do this. The operator's voice training is therefore considered very important; it is directed toward three objectives: improved public relations, increased accuracy and efficiency, and increased ease in speaking. By the way in which she says things, the suc-

cessful operator is supposed to convey to the customer her readiness to do everything possible to give pleasing service. Rising inflection and emphasis on the third syllable of "Number please" is supposed to convey some such impression as, "Good morning, sir, what can I do for you today?" Falling inflection is supposed to be used for, "They do not answer," to convey regret. A good operator's voice must never sound cross or abrupt, nor should it lose its ring of sincerity, enthusiasm and perseverance. Girls with flat, tinny or nasal voices are not usually hired, for subscribers are apt to think them irritating and disagreeable.

Americans often are considered to be somewhat slipshod in speech; inclined to omit sounds and run words together, like, "Whadjadoolasni?" or "Imeetinertemorre." Since habitual speech of this sort does not carry well over the phone and, also, since it gives the impression that a person is careless and lazy, it is not to be tolerated in a telephone operator. Beginning with the vowels, she is taught good clear diction by practising in front of a mirror the correct use of tongue, jaws and lips. She is also taught to direct her tones toward her upper front teeth, where they have more resonance than do tones down in the throat.

Proper breathing habits are also taught in an American operator's training course, because proper breathing is essential to increase the carrying power of her voice, with a minimum of strain and fatigue. It is suggested she walk around, inhaling for six steps, exhaling for six steps, repeatedly, so that it becomes natural for her to take full, deep breaths, and easy for her to speak into the horn-shaped transmitter supported on her chest, with a voice that can readily be heard over the phone, and yet is scarcely audible

one step behind her back. If she were to speak too loudly, her good clear diction would be blurred by the volume of voice going through the phone, and she would find after an hour or so of work that her throat was beginning to get tired.

Several years ago it was customary for operators to use a standard vocabulary. Approved phrases were designed to cover almost every question or response that they might be required to make, but after these phrases were repeated many times, they began to sound mechanical, like "telephonese." When an exasperated subscriber finally blurted, "Are you crazy or am I?" he certainly did not feel very much better to be informed, "I'm sorry, sir, we do not have that information." It is now considered much better practice to emphasize the friendly voice and the "me-to-you" attitude, advise the new operator against the use of "uh-huh, O. K., I see," etc., and then let her find her own words. Skits have been presented to groups of both old and new operators, showing the customers' reaction to the bored voice, the haughty voice, the curt or stilted voice and the exaggerated pronunciation of numerals such as "nyonne, fyuv," and "thurree."

In switchboard technique, each new operator is trained for a particular job, such as local "A" operator, who answers the subscriber, local "B" operator who answers operators calling from other exchanges, or long distance operators. Later, she may receive additional training and do one of many other kinds of operating. The local list includes sender monitoring, information, time and weather operators, intercepting, verifying, trouble and special service (the last for dial exchanges). For long distance work, inward, outward, through, rate and route, and ticket dis-

tributing operators are required, each with her own distinct and specific functions, in the completion of long distance calls. In normal times, most telephone companies welcome the opportunity of showing interested visitors through an exchange where they can see for themselves what the operators have to do.

The map on page 196 will give some idea of how long distance connections are handled. Eight of the largest cities of our nation, cities which are centers of important business activity and of natural geographical regions, have been selected as "regional centers" to expedite service on our coast-to-coast telephone network. These regional centers are: New York, Chicago, Atlanta, St. Louis, Dallas, Denver, San Francisco and Los Angeles. New York and Chicago are connected by one hundred direct lines over four different routes. Rarely are so many lines needed, but instead of as few as possible, enough are provided to take care of emergencies. New York and Chicago, also, have several direct connections to each of the other six regional centers, as well as to the important cities in their own respective regions. New York operators have at their command direct connections to six hundred cities; they can plug in directly on Boston, Buffalo or Philadelphia etc., as well as on Atlanta or Dallas.

The longest long distance call which it is possible to make in the United States is between Eastport, Maine, and Bay, California. Eastport has a population of 3400 with 548 telephones. Now if, perchance, someone from Eastport should have an acquaintance in Bay, with whom he wished to speak by telephone, the procedure would be like this: The Eastport operator would connect him with a direct circuit to Bangor where, as in all other long distance

centers, there is an alphabetical guide showing how to reach by telephone any one of 70,000 places in the United States. In Bangor, a long distance operator would look up the route and toll rate for handling a call to Bay and, with this information, ring the "inward" operator at her regional center, New York. The New York inward operator would transfer her at once to a "through" operator who, with a single flick of the wrist, would extend the connection 3000 miles across the continent, from New York to San Francisco. Inward and through operators in San Francisco, and a long distance operator in Santa Rosa, would pass the call on to Bay, which is a beautifully situated vacation spot whose year-round population of eighty people is served by five telephones. Altogether at least eight operators would have a hand in the completion of such a call.⁹

In addition to the eight regional centers, the traffic circles on our nation-wide telephone super-highways, there are more than one hundred and fifty "primary outlets," each a crossroad for traffic in a more limited surrounding area. Chief among these primary outlets is our capital city, Washington. Long distance operators in Washington can make connections directly over more than 775 long distance circuits to cities east of the Mississippi. On a typical busy day they handle as many as 17,000 long distance calls.

For every toll call she handles, an operator must make out a ticket, recording all the information necessary to accurate billing. When your connection is made, she inserts your ticket in the calculagraph and pulls a lever which stamps on the back of the ticket a sort of clock face, with an arrow pointing to the time when you begin talking.

Before taking another call, the operator also stamps on the ticket, separate minute and second dials, and sticks it in a wire rack to await the signal that you have finished speaking. Then, immediately, she inserts it in the calculagraph again and pulls another lever, which by an ingenious device indicates the exact number of minutes and seconds elapsed since your connection was made.

These tickets are gathered up and sorted into piles according to exchange and number. If you ask on the same day you make the call, the ticket distributing operator will tell you, then, how many minutes elapsed and what the toll charge is; otherwise your monthly bill will convey this news.

Since an operator answers call after call—sometimes as many as a hundred and fifty local ones an hour in metropolitan areas, her work requires considerable concentration. Operators in New York and other large cities, therefore, have a fifteen minute rest period in the middle of both morning and afternoon, and an hour for lunch in between. Healthful working conditions and wholesome recreation facilities are also provided for them, and in some large cities, courses in Health, First Aid, and Nutrition and Menu Planning have been made available for operators at no personal expense.

If you let your imagination play for a few minutes on all the romantic and history-making calls that long distance and especially overseas operators handle, you may think that these girls have just about the most interesting and exciting jobs in all the world. Anytime she plugs in, you think, she may be answering a Hollywood bright light, a Washington celebrity, or some other front page figure, making a call that any newspaper man would give his shirt

to know about; but whatever it is, the most thrilling, the most tragic or the most inane conversation, as soon as she gets it started, another light is flashing for her attention, and she cannot take time to eavesdrop. Company regulations, also, not only forbid her monitoring messages unnecessarily or any longer than is required, but stipulate further that she must never reveal outside, nor as a rule discuss within the office, any conversation which she overhears.

Since the war started in Europe, overseas operators have been handling a large number of calls between President Roosevelt and his diplomatic agents across the Atlantic—calls of tremendous importance to a great many people—the strict privacy of which must be guarded with the utmost care.

Not only overseas calls but also many that are made within our own country, have a vital bearing on our national defense, and the Government regards any violation of their secrecy as criminal. In normal times, a Federal Communication Act puts a penalty of not more than \$10,000 or two years imprisonment, or both, on persons who willfully violate the secrecy of communications, but in times of national emergency, the unlawful disclosure of information affecting national defense is regarded as treason and punishable by death, or by imprisonment for not more than thirty years. Probably because she does it every day, and is kept busy with the mechanics of it, the operator is rather rare who fully realizes how dramatic her job is.

The only city in the United States where operators are required to speak other than English is San Francisco's Chinatown. Here the operators speak, in addition to English, three different Chinese dialects: San Yup, See

Yup, Heong San. In other large cities there are usually operators from homes where Italian, Spanish, German or French are spoken, who can help piece together broken English when the need arises. The operators at public telephone stations, especially in railroad terminals, are often appealed to by travelers who speak practically no English, and have not been met by their relatives or friends as they expected to be. The thirty-seven foreign communities represented at the New York World's Fair also created a special problem. Several of the exhibitors asked the telephone company for operators speaking their language, and their requests were granted. Forty operators were brought along from their native lands and retrained in New York telephone practices and terminology after they got here.

The overseas operators in Miami, San Francisco and New York use English entirely in talking with foreign operators but they have to know how to use the foreign directories to look up numbers. They must know, for example, that Vienna is Wien to the Austrian; Leghorn is Livorno to the Italian; and Munich, München to the German. They must know the names of the principal central offices in large foreign cities, the way street addresses are given in different countries, and the meaning of postal district letters such as S. W. 2 or W. C. 1 in London and *arrondissement* numbers in Paris.

European operators have a much more strenuous time with respect to language. British "telephonists" in peace times, in order to qualify for handling international service were required to be proficient in French, German, Dutch, Spanish and Italian. In the extremely cosmopolitan cities of Cairo and Bombay also, operators had to be able to handle calls in any one of six languages: English, French,

and Arabic were required in both cities ; in Cairo, to qualify for a job, a girl had to know in addition Syrian, Greek and Italian ; and in Bombay, Hindu, Japanese and Chinese. In Shanghai, which has the dial system, the special service operators are required to speak the Mandarin and Cantonese forms of the Chinese language as well as the Shanghai dialect. A luxury hotel in Switzerland was reported, ante bellum, to have made operating even more complicated for its switchboard girls, by requiring them to slip a colored transparent guide, indicating his native language, over the extension number of each guest as he was assigned a room, and to be prepared to respond in the language indicated, whenever a signal lamp flashed. Imagine having to come out quick as a flash with *J'écoute* for the lady from Paris, *Ik luister* for the Belgian gentleman from Antwerp, *Bitte* for the German or Austrian, *Prosím* for the Czechoslovakian emigré, *Per servila* for the diplomat from Rome, *Moshi moshi* for the Japanese banker, and then be able to follow up with the proper responses.

The qualifications for American operators are such that as a rule they are attractive, marriageable young women, many of whom leave their switchboards to make homes. Those who remain, married or not, as most of them do for about twelve years, may become supervisors or even chief operators. From the pictures of them in telephone company advertisements one might think that any operator could model for the typical American girl, but a visit to an exchange, where a large number of them are working, reveals tall ones, thin ones, short ones, fat ones, the young and not-so-young, the stylish and not-so-stylish, as in any other group.

As there are many types of individuals so there are many types of jobs among operators. Telephone companies employ local, long distance and overseas, weather, time and information, and public telephone station operators. In addition, there are police and stock exchange operators, and private branch exchange operators employed by private concerns.

The most important thing about the local operator, as far as most of us are concerned, is her presence and readiness, at all hours of day or night, week day, holiday or Sunday, to serve us. She and our telephone (or for some of us city folks, the pay station in the store on the corner) give us a comfortable sense of security, and the assurance that a call for help of any kind will meet with immediate and effective response. If we are feeling lonesome, she will bring us the voice of a friend. She will get us a doctor, ambulance, policeman or fire apparatus, in an urgent moment; and just as promptly and pleasantly, she makes all the humdrum connections with grocers, butchers and drug stores, with relatives and friends and business associates that save so much time and energy in our daily routine.

It is also the local operator who keeps working heroically while floodwaters swirl around the telephone building, and boats, uprooted trees, and the debris of houses, go rushing by. During the hurricane which ravaged Long Island and New England, in September, 1938, local operators stayed at their boards answering frantic calls for help, assuring marooned persons that their plight was known and reported to the proper agencies, and that help was on the way. Not until their boards were almost entirely out of

service, and firemen in oilskins and sou'westers came to take them out in row boats, did some of the operators in the storm's path consent to leave their places.

Several refugees from Europe, notwithstanding their strangeness and foreign accents, have found American operators so uniformly kind and helpful that they have gone to various telephone business offices to express their appreciation. The gist of what they wish to say is this: "In spite of my being a refugee, far from home, and speaking your language very badly, whenever I drop a nickel in a telephone slot I meet a friend. The operator seems to be a symbol of the American spirit."

Locating the person called for, is the forte of the long distance operator. Damon Runyon in his widely syndicated column "The Brighter Side" wrote recently:

We will back the long distance telephone operators of the United States in the matter of finding a desired party against the post office people, the telegraph companies, or even J. Edgar Hoover's redoubtable Sams.

As a matter of fact, if we were J. Edgar Hoover, we would save ourself a lot of running around at times by just picking up the phone and requesting the long distance operator to locate the person we wanted—say some fellow like Mr. Lepke Bucholtz, who is an absentee from justice.

"Get Mr. Bucholtz on the wire" we would say to the operator. "B, as in baffling. U, for useless. C, for cunning. H, for hiding—yes, that's right. Bucholtz. He used to hang out in Pete's place on Delancey street. Call us when you get him."

Inside of half an hour the operator would probably be back on the line saying in that sweet tone of voice characteristic of all telephone operators :

"Mr. Bucholtz has gone to Palestine. Do you wish me to call him there?"

Many stories are told of the ingenuity and persistence of long distance telephone operators in "getting their man." There is one about an operator who was asked to locate a man driving to Florida; his mother had become suddenly ill and he was wanted at home. The operator asked if he made a habit of always using one kind of gasoline. "Yes, he has a credit card for Standard," she was told. The next time he stopped to fill his tank, the man received the message about his mother. "Long Distance" had asked more than fifty service stations to look out for him.

Overseas operators have a similar reputation. One of them recently traced an American traveling in Europe through three countries and connected him in less than three hours with his friend who was calling from Charleston, West Virginia.

When overseas service was first opened, and relatively little used, a Long Island society matron called her daughter in London. The rate was then seventy-five dollars for three minutes. The two ladies chatted with animation, but—so far as the operator whose job it was to monitor the connection could discern—to no particular purpose, about bridge and clothes and a polo game. Three minutes elapsed. The conversation continued about a luncheon at the Plaza and a new family car. Another three minutes elapsed. The operator was getting worried. Did these ladies know what a bill they were talking up? At the end of ten minutes the latest trick Sandy's puppy had learned was being described. The operator's sense of economy was touched to the quick. "Pardon me," she said, "but I wonder if you know that you have been talking ten minutes and that the charge is two hundred and fifty dollars?" "Yes, thank you, my dear," the lady replied,

"I'm planning to talk twenty minutes."

Being an overseas operator develops an intimate feeling toward the world. From their several years of daily conversation with operators in Tokyo, the overseas operators in San Francisco find it hard to believe that it takes twelve or fourteen days to cross the Pacific by boat. The girls in New York feel as if they had many friends in Rio and Buenos Aires. And when the London overseas operators, with whom they had spoken daily since transatlantic service began, announced on September 1, 1939, that they were having to sign off on account of the war, some of the New York operators, for a few minutes had difficulty in fitting plugs into jack sockets.

Weather reports are a rather new feature for the telephone. In the days of personal relationship between subscriber and operator, weather forecasts were frequently asked for and supplied; in some communities they have continued to be supplied by "information," but in large cities services which usurped an unusual amount of operators' time were not looked on with favor by telephone officials. When the number of calls for the U. S. Weather Bureau in New York City, however, resulted in the busy signal on as many as ten thousand calls a day, something had to be done about it; people who really needed particularized and technical weather data were unable to get in communication with the Bureau, and the telephone company was losing many nickels from people who wanted to know whether they ought to carry an umbrella, or leave their topcoats at home.

And so it was arranged to have four government weather reports daily, at 7 and 10:15 a.m., and 4:30 and 7 p.m., supplemented by hourly changes in temperature and hu-

midity, teletyped into a small soundproof room in the Telephone Building on West Fiftieth Street. There, an operator reads the forecast into a telephone transmitter that is connected with an instrument which records what she says on a narrow strip of metal tape forty feet long. When a change is to be made in the announcement, the previous recording is erased by a quick magnetic process, and the new recording is made on the same tape. Weather operators are chosen for voices distinct and audible but as gentle and soft as possible. There are twenty-two of them who take turns, alternating with regular switchboard work. Many callers do not know that the dulcet tones they hear are really a disembodied voice; some of them ask questions and a few say "thank you!"

An average of 20,000 calls a day come in to WEather 6-1212, and half a dozen other cities in the country are now offering weather announcing service similar to New York's. The number of calls is greater on Fridays with people making week-end plans, and during the summer vacation months. The majority of the calls, however, come from people whose business is affected by the weather. The fruit merchant wants a forecast to help him determine just how much to stock in highly perishable commodities, and the air-conditioning man needs frequent readings of humidity. So it is also with the superintendents of huge office buildings, who can stock up only a limited supply of coal, and must worry about available storage space. If rain is coming, the restaurant man knows he must get in extra supplies of food and hire extra, temporary help, for rain drives customers into his place. Baseball fans from out of town also use this service to be sure the game is being played. During the World's Series games in New York

a special announcement was added to cover this point. Subscribers called all the way from Boston, Milwaukee and Dallas, probably deciding whether they should go to the office or stay at home and listen to the game on the radio.

It seems strange that the weather report, which is more complicated, should be recorded and that an operator should actually have to sit in front of a telephone, watching a clock and repeating every fifteen seconds, "When you hear the signal, the time will be four twenty and a quarter. When you hear the signal, the time will be four twenty and a half," etc., but it is so. This is because the wording of the weather report is exactly the same for at least an hour while the time report is always changing. Regular operators are designated in half-hour shifts for this monotonous job. If during some quarter of a minute no light appears on her board to indicate that some one is listening, an operator can skip her refrain but this seldom happens. In New York City, an average of 60,000 calls a day are made for the correct time.

In some places where the telephone company does not do it, enterprising individuals make a business of time service by getting local merchants to sponsor them. They advertise their time service in the telephone directory and in the shops of their sponsors, and between time announcements they tell about Springers' sale of grass seed, Brown Brothers' special on percale sheets, and so forth.

"Information" in a large city is hundreds of operators in several exchange centers. Each operator sits in a three-sided compartment, almost surrounded by directories which are very much more up-to-date than ordinary ones. Local directories used by information operators usually contain listings of phones installed within the last twenty-four hours,

and in many cities there are two, one the alphabetical name directory and the other an address directory, with the streets listed alphabetically and the numbers under them in regular sequence. From this address directory it is a simple enough task to find "the shop that sells stockings and lingerie on Broadway near 29th Street. I can't remember the name." In fact the ideal call from the information operator's point of view is one in which the caller first gives the address.

The majority of calls to Information are by people who say they have forgotten their glasses, or are in a place where there is no light. Operators sometimes suspect that callers are just too lazy to look up what they want to know, or else that they are very poor readers. The "silk-stockings district," where "society" lives, some say, provides the worst offenders in asking for help on things they could perfectly well find for themselves and then forgetting a "thank you." "Big business" districts are the nicest to deal with, Information thinks, but they are not always the most interesting. It is from the housewives that the long story calls come: "Can you tell me the names and addresses of some kennels near such and such a highway? You see we were bringing our dog home from the country and he got excited and jumped out of the rumble seat and some kennel called us and said he had been brought in there. We had our name and address on his collar, but I was so excited when they called—I thought I could remember the name and place so I didn't write it down—and then it slipped my mind—but if you could tell me the names and addresses of some along such and such a highway I'm sure I'd recognize it."

Calls like this, of course, slow down a speed record, but

even so the average rate is about fifty seconds per call, fifty-four calls an hour. Visitors from Shanghai to a New York information bureau were amazed at this because in China, they said, it takes at least a minute to get through with the polite formalities and satisfy the operator's curiosity about yourself, where you are, the person you wish to call, why you wish to call, etc. The regular rush season for information is Christmas, when shoppers are calling for information about stores, and many people are trying to find the addresses of friends and relatives with whom they communicate once a year by greeting card.

Where rural operators in Virginia, West Virginia, Maryland and Delaware have been replaced by community dials, which require no more attention than an occasional visit from a repair man, in order to keep up a little personal touch with its subscribers the telephone company operating in that area has introduced a rather special information service. Here in addition to questions concerning the time and the weather, you can ask whether the snow plow has opened the road between Doswell and Gum Tavern, whether the bus from Washington is expected to be on time at Greenbelt, how the market is on oysters, what's playing at the local movie house, when and where church fairs, sporting and social events are being held and Information will do her best to get the correct answer for you. She has even supplied recipes for this or that dish. Where she has to draw the line is on news flashes which might interfere with subscriptions to the local paper.

Similar service is reported from Calcutta, India, where the Bengal Telephone Company opened a bureau, very popular with British subscribers, which answers such questions as, "Will you please tell me the Hindustani equivalents

of indolent and disobedient so that I may scold my servant?" and "What is the variation in the boiling point of water per thousand feet above sea level? My tea does not taste right up here in the mountains."

In Sweden, before the war, they had "speaking machines" like New York's weather reporter to give out information on skiing conditions in various places, and on how the wind and water were for sailing or swimming.

In general, however, this type of information service is not looked upon with favor by telephone administrations, because it consumes a great deal of time without bringing in revenue. They also discourage the asking of questions which can be answered by the books which they supply to every subscriber. In many places abroad a fee is charged for even supplying telephone numbers.

Operators in attendance at the public telephone stations are the only ones employed by the telephone company who see and are seen by their customers. These girls are outfitted in very smart-looking uniforms and sometimes have headsets in matching color, brown and green perhaps to go with their winter costume, navy blue and white for the summer. Being decorative, however, is by no means the biggest part of their job. Unofficially they constitute a sort of Travelers' Aid Society. Strangers in town feel that these operators are especially human and likely to be helpful. The aged Polish woman who cannot find the daughter she came to visit for Christmas, the negro man with two small children from the South trying to locate a relative, the timid girls looking for a decent place to spend the night, all appeal to the public telephone station operator. Maybe they had a friend or knew a girl who was an operator back home; it's very likely, because the

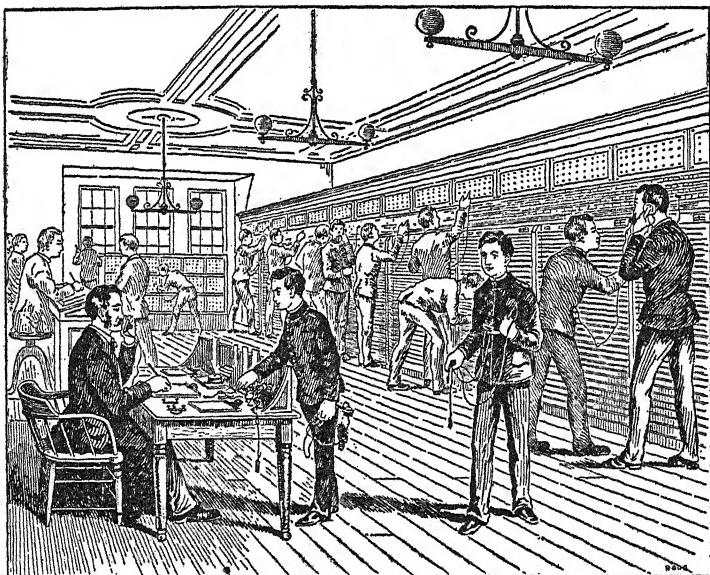
telephone operator belongs to a very large and world-wide sisterhood.

Not all telephone operators are employed by the telephone company — not all by any means. As a matter of statistics, in New York City for example, private branch exchange attendants, alone, that is girls who operate the switchboards in hotels, large offices, hospitals, stores, and other busy establishments, outnumber the telephone company operators three to one. Then there are the forces of special operators at the Stock Exchange and the Curb Exchange. There are also the "switchboard cops" who play a vital role in police work, and are usually trained for switchboard operation by telephone company instruction classes.

The busiest hours of the operator's day in a typical city exchange are: between nine and ten in the morning, when business is getting under way, stores and offices are opening and housewives are placing their orders with the butcher, grocer and vegetable man; and between four and five in the afternoon, when last minute arrangements for the next day's business or the evening's social engagements are being made. A stormy day that makes people stay under shelter, or an interruption of subway, train, or street transportation service, increases telephone traffic very noticeably. A serious accident, also, generally sends an unusual number of anxious friends and relatives to the phone and makes a hectic time for the operators.

Figuring out how many operators will be required each hour of each day at each office is a complicated problem. Thousands of observations have been made to determine the time required by an operator of average experience and ability to handle the several different types of calls. About a hundred and twenty to a hundred and fifty local calls

per hour are what the average operator is expected to handle. To accommodate fluctuations in traffic with the operators' five-day, forty-hour week, standard tricks have been worked out. A "trick" is the day's work of any one operator; it is composed of two sessions. It may be morning and afternoon—morning and evening—afternoon and evening, or night. Operators continually are exchanging tricks, the same ones do not always work Saturdays and Sundays; they have some choice as to their days off, but it is very important that they let their supervisors know when they are not going to be on the job, so that someone else can be called in, for Mr. John Q. Public must not be kept waiting.



Boy Operators. Switchboard of Gold and Stock Telegraph Co.,
New York, 1879

CHAPTER VI

TELEPHONE DIRECTORIES

WHEN THE TELEPHONE BUSINESS WAS FIRST BEING DEVELOPED, lists of subscribers were printed on long narrow strips of paper, which served to show who were the progressive citizens already using the new instrument of communication. These were intended to encourage increasing use of the telephone and to stimulate others to become subscribers. They were the forerunners of the present-day telephone directory. Since the telephone was used almost exclusively for business purposes in those days, the subscribers' names were grouped under headings indicating their professions or the sort of merchandise they sold.

One such list, published in Boston, under the caption, "The following firms have already subscribed:" begins with, Amos Plow Company, continues with the headings, Banks, Boots and Shoes (under neither of which are any subscribers listed), China, Glass and Earthenware (four subscribers), Druggists, eight; Grocers, four; the headings Lawyers, Iron and Steel, Leather, Millinery, Publishers—all are followed by blank spaces.

The list of subscribers of the National Telephone Exchange in Washington, D. C., as of April 8, 1879, among others, included: Adams Express; Associated Press Office; Bell, Prof. A. G.; Capitol, U. S. (Senate corridor near Secretary's office); Executive Mansion; Hubbard, Gardiner; Institute for Deaf and Dumb; N. Y. Herald, N. Y.

Sun, N. Y. Times, N. Y. Tribune, Treasury Department (office of the Captain of the Watch).

New York City's first telephone directory was also a single sheet of paper and contained no numbers. The names and addresses of 271 subscribers were listed in two columns arranged alphabetically under such headings as Banks, Bankers and Brokers, Tea and Coffee, Fish and Meats, Produce, Cotton Oil and Commission Merchants which now seem hodge-podge, but were probably logical enough in their day. The sheet, about two and a half feet by nine inches, was usually fastened on the wall beside the subscriber's telephone. In 1880, fifteen hundred phones were in use in New York, but though the list of subscribers was printed up in a book of forty-eight pages, it was still by names without numbers.

When the telephone business had grown to this point, however, it was complicated and inconvenient to handle by the original system. Early in 1881, therefore, it was announced: "Subscribers will, in future, be known to our operators only by Central Office name and subscriber's number and not by subscriber's name." The new book of a hundred and fifty pages, as an aid to patrons in identifying the new numbers, included the business designation and street address on the same line with the alphabetically listed names and numbers. Many objections to the bother of looking up numbers were emphatically voiced then, just as they were to dialing numbers fifty years later.

In those days, it was possible to include the listings of all subscribers in the United States in a single book. With the development of toll lines, an effort was made to continue to do this and, for several years, a national telephone directory was published, which listed all Bell System sub-

scribers between whom communication was possible. The last of these directories was issued in 1897. Its pages were a trifle larger than those of current directories, but it was not as thick as the Manhattan volume of the New York City directory today. Its total circulation was a hundred and fifty thousand copies.

To combine in a single volume the listings of the fifteen million or more subscribers in the United States today, would require a book a yard and a quarter thick, with almost forty thousand pages. Instead of such a cumbersome volume, however, there are some thirty-six hundred directories of American telephone subscribers, ranging from two-page cards for some of the smaller exchanges to the fifteen hundred page Chicago directory, the thickest one in the United States. For all of these a total of over thirty-five million copies are distributed free to subscribers, at an annual cost to operating companies of about twenty-five million dollars.

So large a job and so integral and important a part of Bell System telephone service has the directory become, that the American Telephone and Telegraph Company has a special group of "engineers," whose function it is to furnish advice on all aspects of directory publishing, including production, sale of advertising space and special services. Paper, type, type metal, printing, proofreading methods, alphabetizing, regulations with respect to listings, delivery, what to do with old copies, all of these and many more are their problems.

Clearly, when telephone directories began to expand so prodigiously, they could no longer be printed on heavy book paper as they once were. Thinner paper was needed, but it also had to be durable and it had to be cheap. Reg-

ular newspaper stock was tried for a while, but newspapers are usually read once or twice and thrown away, while telephone directories may be referred to and handled continually for six months or more; furthermore, dirt specks or glossy spots which do not take ink well, do not prevent a reader from arriving at the sense of a newspaper article, and even if several words are blurred it makes little difference; but if in a telephone directory, a single number fails to be perfectly clear, a host of subscribers may be greatly inconvenienced. These two essential differences between newspapers and telephone directories made the use of regular newsprint very unsatisfactory.

The principal paper mills of the country in New York, Maine, Wisconsin and Minnesota were visited and their practices studied. Then paper-testing technicians were set the task of developing a newsprint suitable for directory use, whiter and cleaner than ordinary newsprint with a better finish and surface texture, with an opaqueness for printing on both sides without showing through, strong enough to withstand high speed printing and frequent handling, and yet of practicable bulk and weight. The durable "blue-white" catalog paper in current usage is the result. Over thirty thousand tons of it go into Bell System directories every year. If this were all joined together in a strip eleven inches wide (the height of the usual phone book) there would be enough paper to wrap around the earth's equator more than fifty-five times.

Attention was also given to making the type of letters and numbers as small and close together, and yet as legible, as possible. By dispensing with serifs and shaving some of the thickness from the inside of enclosing lines, so that more white space could show through and around letters and

figures, a special open type face known as "Bell Gothic" was designed. It was so much more clear and legible than other type of the same size that it was adopted by the Shanghai and the Australian telephone administrations as well as by most American companies.

With the thinnest paper and smallest type practicable, however, the New York City directory by 1923 had grown to 855,000 listings and 1726 pages. This made a volume over two inches thick and a discouraging number of columns of Smiths and Cohens to look through. A separate directory for each of the five boroughs of New York City then came into being.

Moving day for the American city dweller is more than likely to be around the first of May or the first of October. The number of changes in address and telephone number, which occur at these times, make the information and intercept operators very busy indeed and cause subscribers some inconvenience. It would be desirable to get out new directories on moving day, but directory printing and distribution is such an enormous job that this is hardly possible.

The size of the job in metropolitan areas, and the speed with which it must be done, have necessitated a high degree of standardization in equipment and techniques. Not many printing establishments can handle it; there are five or six scattered over the country which do practically all the bulk of the nation's larger telephone directories, and a schedule is worked out so that the large directories which are issued semiannually and those which are done only every nine months or so (depending on the number of new customers who are eager to have their names appear) can be handled successively. This schedule keeps the special per-

sonnel and machinery busy fairly regularly, instead of in tremendous spurts.

The largest job in telephone directory printing is done by the Jersey City Printing Company. From its presses twice a year come over three and a half billion pages of telephone directories for the New York metropolitan area, several counties in New York and New Jersey, Baltimore, Maryland, Washington, D. C., Philadelphia and a dozen or more other cities and towns in Pennsylvania.

This company, like the others, prints both "traffic records" and directories. Every afternoon they receive, by special messenger or by teletypewriter, lists of that day's new installations and changes, from several of the areas which they supply with directories, and each night, soon after midnight, a new traffic record is printed and ready to be delivered to the various information bureaus. It is fairly general practice to cumulate these records daily for about two weeks, adding the new names each day in alphabetical order to the printed list for the several preceding days. Every two weeks each New York information operator receives two complete new up-to-date directories, one arranged according to subscriber's name, and one according to address. Information in Detroit receives complete new local directories every morning; in Los Angeles, every other morning.

Since about two thirds of the listings remain unchanged from one issue to another, and since accuracy is so important to a telephone directory, the type for the unchanged listings is used over and over again in order to save proofreading and to lessen the possibility of errors. In the larger cities, where traffic records are printed from the

type, regular type metal was found to be too soft; its sharp edges soon wore off and the printed letters became fuzzy. A special type metal, therefore, was developed which cannot be scratched with the finger nail like ordinary type metal; it is hard and brittle like glass.

This type, which is kept set up for traffic records, is practically ready for use when the time rolls around to issue a new directory for subscribers. After slight rearrangement, the type is formed into pages. Plates are then made of many pages at a time and clamped fast to the large rollers of a hundred or more horsepower printing press. From the presses with the largest capacity, signatures of seventy-two pages each, all folded in the proper sequence, roll off at the rate of fifteen thousand signatures, or about twenty miles of paper, an hour.

The assembling and binding of these signatures into complete directories is all done by a most remarkable and fascinating machine, or rather series of machines (stretching for fifty feet or more) all geared together and each performing a distinct operation. First, there is the part that picks up in numerical order one copy of each signature, so that pages 73-144, for example, are added behind page 72, then 145-216, and so on. When these are all assembled with their edges even, and the folds all together, they pass a very sharp knife, which comes down and cuts off the folded portions. Next, the assembled signatures, all tightly held together, have to pass two wire brushes, which roughen up the smooth cut edge just made. Then a coat of latex cement or glue is applied to this roughened surface while it keeps moving, on past a device that slaps a strip of cheesecloth of exactly the right size over the sticky back of the book, and others that add the heavy paper cover,

fold it snugly over the printed pages, and stack the completely bound volumes in neat piles to wait for the glue to dry. The final trimming and packaging is done on separate machines, before the finished directories are loaded on trucks or freight cars to be sent to their respective distribution centers. For the hundred and seventy-five largest directories, thirty-five is the average number of calendar days from the date when the listings are closed, until they are delivered to subscribers.

Six hundred thousand copies of the Manhattan (New York City) directory alone are distributed every summer; the winter issue is still larger. Into the smaller of these have gone something like 1000 tons of paper, 26 tons of cover stock, 13 tons of ink, 6 tons of glue and 23 miles of cheesecloth. Some one has figured that it would take fourteen and a half miles of shelves to stand them on if they were all to be kept in one place.

A unique directory, from the point of view of production, is the one for San Francisco's Chinatown, probably the only foreign language telephone directory in the United States.¹ It lists approximately 2100 phones for the Chinese who live together in a fourteen square block section of the city. With a pencil-shaped brush dipped in sepia ink made from cuttlefish caught in the ocean near Monterey, California, a young Chinese writes out the original copy of the thirty or more pages which comprise the Chinatown directory. This is reproduced in quantity by a lithographic process.

The distribution of directories in small communities to widely scattered subscribers is sometimes done by mail, but in general it is contracted for by concerns that make a business of distributing samples. At new directory time,

regular armies of men invade a city, arriving with their heavily laden trucks and following prescribed routes. While private residences usually receive one copy for each telephone on the premises, several tons of directories are delivered to some large apartment houses and office buildings. The tenants of Rockefeller Center, alone, receive over seven thousand copies, or about twelve tons, of each Manhattan issue. To tell them where to go, and how many copies to leave, the delivery men have lists or a card for each subscriber. It costs, on the average, about four cents a copy to deliver the directories.

As a rule, when new ones are delivered, the old directories are collected, so that people cannot continue to use numbers that have been changed. Most of the old directories are sold as raw material to boxboard manufacturers. A large paper manufacturer in Wisconsin, however, has been experimenting with a non-carbon ink for printing the directories, so that the paper in the old ones can be cleaned and used, instead of wood pulp, as raw material for making up again into rolls of newspaper stock.

Since the earliest lists of telephone subscribers were, after a fashion, classified, the classified directory is as old as the telephone business itself. From the beginning, it has served as a "buying guide," for in it local merchants and purveyors of services have been listed under classifications generally descriptive of types of business, commodities or services. This feature in itself proved to be so useful to consumers and so profitable to suppliers that classified listings of subscribers to business phones have continued to be included, as a supplement, in most sizable directories. In four cities, the classified sections grew to such proportions that they were printed in separate volumes, the "Red Book" of Man-

hattan, and Brooklyn, New York, and Chicago, and the "Yellow Book" of Los Angeles.² There is one special business directory also which includes five of the New England States.

It is interesting to compare some of the older classified directories with current ones, not only for the picture it gives of ever-changing business life and social usages, but also for the changes which have taken place in the organization and make-up of the directories themselves. The horse collar makers, carriages and wagons, oyster saloons and automobile goggles have vanished; the miniature golf links came and went; and many new headings appear each year, recent among which are air line companies, blood donor agencies, television apparatus, and trailers—house. The passing of the dry goods store and hairdresser, and the rise of the department store, beauty parlor and delicatessen are clearly shown by successive classified directories. Forty years ago, who would have looked for air conditioning, cash registers, dog and cat hospitals, radios, X-ray supplies or zippers?³

Along with changes in things themselves have also come changes in names. The old undertaker has become a funeral director or a member of an association called morticians; an association of real estate agents, are realtors. Because of its exclusive nature, however, this association terminology is not used for classified directory headings. And although exterminators now aim to be known as pest control companies the Bell System will use this new designation only as a cross-reference until the public has been made familiar with it in other forms of advertising.

Whereas, in the old days, little need existed for the control of headings, and they seem to have been made up some-

times with little regard for reason, the Bell System, aiming to make the "yellow pages" of its directories of the greatest value and convenience to its customers, has recently distributed to all its general commercial managers a forty-five page memorandum, entitled "Classified Heading Practices and Illustrative List of Headings." The idea is to introduce greater uniformity of terminology and more discrimination in heading selection, to the end that fewer, more appropriate and serviceable headings will be provided which will catalog, without duplication, the business activities in the community. Complications are created by the fact that people from different sections of the country call things differently. While a New Yorker, when in need of legal advice, will look for a lawyer, a Southerner is more apt to look for an attorney or a counsellor. What to the Easterner is a trailer camp, to the Westerner is known as an automobile court.

When a person contracts for the installation of a business phone, he is automatically given one listing under a regular heading in the Classified Directory. If he wishes his name to appear several times under various headings which apply to his business, he must pay for the extra listings.

This type of advertising does not create a want for something as other forms of advertising aim to do, however; it is not promotional. But if a want exists, it points out where the want may be satisfied; it is "directional" advertising. Surveys made in the Middle West, to determine the most important factors in the making of a new customer, indicated that the greatest influence was personal recommendation; a man's friend says, "This suit I got at Schwarz Brothers surely has worn fine," and he is inclined to buy his next suit from Schwarz Brothers. Second in

the list of influencing factors was the classified telephone directory.

When telephone directories first appeared, little was made of trademarks or national advertising, but as the nation expanded industrially, the distribution and advertising of branded or trade-marked goods and services, on a nationwide scale, greatly increased. Until recent years, however, there was no sure and ready means whereby a prospective purchaser could find the local dealer, agent or representative of a particular product or service by its advertised or brand name, or trade-mark. In most cases, a person who wanted to buy something of this description had either to "write for booklet and name of nearest dealer," or "shop around" locally until he found what he was looking for.

There were two serious disadvantages in this situation. In the first place, it was a real inconvenience to individuals who, having made up their minds that they needed or wanted certain specifically identified things, had difficulty in finding where to get them. Second, it was a weak spot in the nation's economic life, since dollars spent for national advertising, having created a desire for the purchase of the advertised product or service, could not in most cases follow through by directing purchasers to the point where that desire might be gratified. The classified telephone directory has been able, fairly well, to fill this gap.

While many telephone companies sell their own directory advertising, some prefer to engage the services of a regular advertising selling agency. The Reuben H. Donnelley Corporation, of Chicago, is the best known of these, because it handles the three separate Red Books, but there are several similar organizations that solicit the advertisements and extra listings for the yellow pages in the

back of other directories.

There are several companies also that make a business of the publication of directories. One of them does the whole job of providing directories for about seventeen hundred communities in the United States and Canada. It sends representatives into small places which may perhaps have only a mimeographed list of subscribers and, for a percentage of the advertising revenues, provides them with a printed book, bound and delivered.

People have become so accustomed, through the years, to using the telephone directory that some of them have forgotten, if indeed they ever knew, the existence of the city directory. There was a time when city directories could be consulted in corner drug stores, railroad stations and post offices but in places where they are still kept up, today, they are less accessible and less often referred to. The telephone directory is so ubiquitous and convenient to use that we never stop to think what we should do without it.*

We use it not only when we want to make a phone call, but for locating places to which we are going or sending mail, making business contacts and mailing lists, discovering the whereabouts of long-lost friends and sending out our Christmas cards. Many people also seem to use it as a safe depository for paper money and documents of various kinds; despite the admonitions of telephone executives, stories continue to appear about twenty-dollar bills and insurance policies which were hidden in the phone book just a few days before it was collected. Visitors in Honolulu have a way of taking phone books from there as souvenirs; they're not very thick and they have such an interesting collection of Chinese, Japanese, Hawaiian and

American names.

Some people use the phone book, too, for amusement, making up various kinds of games of solitaire. They look for queer names like Carroll Bird, C. Hawkes and Johnie Wrenn, all connected with the Audubon exchange, or for such ones as "Angel Garment Corporation, manufacturers of the finest dresses exclusively for the funeral trade." They also look for numbers that repeat street addresses or have some association with the subscriber which makes them easy to remember, like Pittsburgh's "Atlantic 1776" for the Sons of the American Revolution. A somewhat more stimulating pastime is trying to make words out of telephone numbers by substituting corresponding dial letters for the numerals, thus MU4-9867 becomes MUG-WUMP and CO5-6639, BOLONEY.

A few of us perhaps assume that we know all about the telephone directory, take for granted that it contains telephone numbers, and do not notice the new features that are being introduced from time to time. In some progressive schools, a study of the telephone book, and practice in using it as a source of valuable information, is part of the regular curriculum; but grown-ups are expected simply to keep their own eyes open.

The new policy of keeping the stiff cover free from advertising, of course, makes for a much more pleasing and dignified looking book, and several western communities have tried to make their directories more attractive by putting pictures of local historic or scenic interest on the covers. Many Bell System directories have on the front cover the Spirit of Communication, a figure drawn from the statue that stands atop the American Telephone and Telegraph Company building at 195 Broadway in New

York City, and several of the independent companies have adopted another similar figure, symbolic of a swift messenger.

The most interesting new feature is the Civic Section. This consists of from one to ten pages of useful and interesting, current information concerning such things as : local post office substations, postage rates and air mail ; transportation facilities, local points of interest, traffic rules and regulations ; city maps showing streets, highways, parks, and public buildings ; the addresses and telephone numbers of principal buildings, etc. An index to the location of streets and facts about the history, industries, educational facilities, population, hotels, etc. may also be presented. In Cleveland and one or two other cities, the new Civic Section was found to be a very real help in promoting safety campaigns which, at the time it was issued, were being given special attention by local authorities, newspapers and civic organizations.

In the old days, people used to pick up the receiver and say, "Hello, central." Though they connected it with the operator, this "central" was really an abbreviation for central office. Nowadays we hear more about exchanges. Technically speaking, a telephone exchange is a unit for administering telephone service in a specified area. A central office is an operating office in which all the lines of a certain area terminate, and where calling parties' connections are made. In places where there are only a few thousand subscribers, the exchange may consist of only one central office, which may be called by the place name. Allentown, Pennsylvania, for example, is an exchange area and it has only one central office, which is called Allentown. Miami, Florida, has several central offices but they are des-

ignated simply by one-digit numbers. Milwaukee has sixteen central offices, designated by as many different names.

Before 1900, it was customary in large cities to call a central office by the name of the street or neighborhood in which it was located. As the business expanded, and more and more central offices were needed, this method often resulted in names which sounded so much alike that they were easily confused; others, therefore, had to be selected. Many lengthy lists of what seemed like possible names were compiled from dictionaries, encyclopedias, postal guides, atlases, mythologies and other sources, but when all those that were not easy to read and say and hear and remember were sifted out, it always seemed that about two hundred and fifty suitable names were all that remained. Several cities were already rapidly using up this meager supply. Introduction of the dial system introduced additional problems. With dials the sound of the central office name was not so important as its first three letters; these could not come in the same finger-hole, for any two central offices in the same exchange area. *Abingdon* and *Cairo* could not both be used because, though they sound nothing alike, they are identical when dialed. The plan finally adopted involved only a simple change from the one with which the public was familiar, and yet it made ample provision for many years' expansion. It retained as many of the neighborhood and historic names as met the technical requirements of calling, either by voice or dial, and greatly enlarged their usefulness by merely adding a distinguishing numeral to each central office name. *PLAza*, for example, became *PLaza 3*. *PLaza 5* could be added when another central office was needed for that neighborhood. (New offices are added when the number

of subscribers' lines begin to crowd 9999, partly because people cannot easily remember numbers with more than four digits, and partly because it is more practicable from the operating and traffic standpoint to organize equipment and staff, in units serving not more than ten thousand lines.)

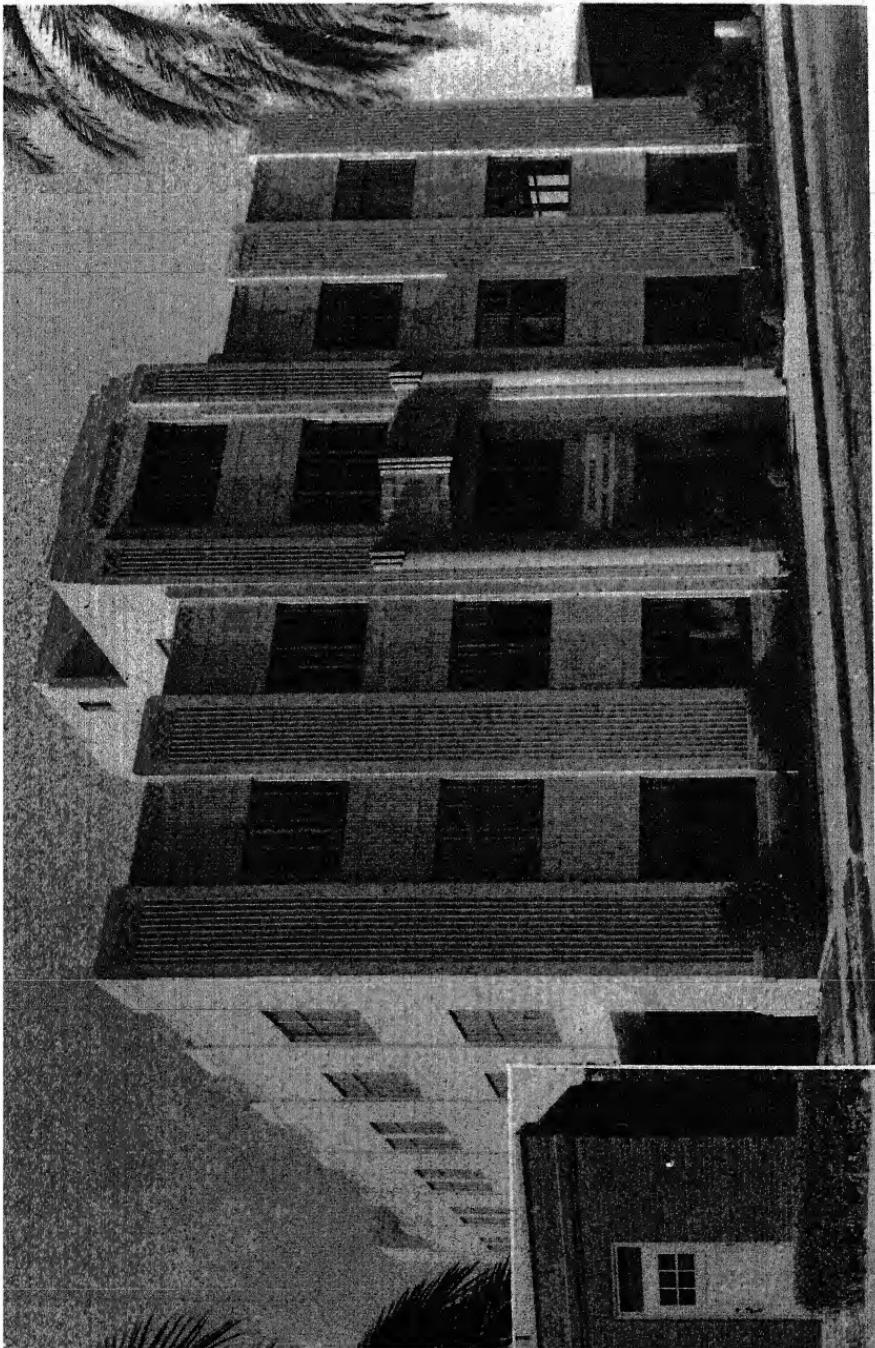
New telephone subscribers in this country, in general, take no part in the selection, but are assigned either new numbers or numbers that have been idle at least a year. Some large and frequently called subscribers, by special arrangement, are given numbers easy to remember or difficult to confuse.⁵ Newspapers, railroads, very busy banks, manufacturers and department stores, for example, frequently have a band of numbers, from 1000 to 1050, let us say, on a private switchboard, but use only the even thousand for directory listing. When such a number is called at a dial central office, a hunting device tries each successive line in the band of numbers until one that is not busy is found.

Some subscribers, for various reasons, prefer not to have their phone number listed at all. On first thought, one might guess that these are people, frequently in the headlines, who wish to protect their privacy; but on looking through the names marked "N pub" in an information operator's address directory, most of them seem to belong to relatively little-known folk,⁶ who wish the convenience of a phone for themselves, but do not want to be bothered by incoming calls. If someone wishes to call such a person, he must identify himself to a telephone traffic supervisor and explain the nature of his call. The subscriber's approval is necessary before the call is put through.

In New York City, are two similar collections of telephone directories, almost complete for the whole world:



File of foreign directories for reference in handling overseas calls. Inset: Tokyo directory



Independent Telephone Co. buildings. Earthquake-proof automatic exchange, Long Beach, California.
Inset: Typical rural automatic exchange

there are over fifty directories for Canada ; one for Juneau and Douglas, Alaska ; one for Algeria ; fifteen for Argentina ; eight for Australia ; one annual for Iceland ; a biennial one for Italy and Possessions which sells for eleven dollars. One volume for Mombasa and Nairobi, Kenya Colony, lies between five for Japan and one for Latvia, in a steel file cabinet drawer. Java, Bali and Madura are all in one annual directory. The list concludes with Tunisia, Union of South Africa, Uruguay, Venezuela and Yugoslavia. There are twenty-one drawers full, in all, representing a total list price of something over a thousand dollars.

One of these collections is available at the New York Public Library ; the other is in a private office. Homesick strangers, it is said, often seem to find consolation just turning the pages that bear the names of their friends and erstwhile neighbors. Several people, who have been entreated to serve as sponsors by European acquaintances wishing to enter this country, have had to consult foreign phone books to refresh their memories about the would-be protégés. Property men from Hollywood and Broadway occasionally order a foreign directory as an authentic detail for a realistic set. More than for anything else, however, these collections are consulted in the preparation of mailing lists by all sorts of businesses, institutions and philanthropic organizations.

Collections of phone books for various cities, from the earliest to the most recent, are sometimes consulted by lawyers and others to establish the identity or residence of a client, heir or long-lost mate. Several of these directories have been subpoenaed and presented as court evidence. The telephone directory, like each man in his life, "plays many parts."

[A Copy]

LIST OF SUBSCRIBERS

New Haven District Telephone Company

OFFICE 219 CHAPEL STREET

February 21, 1878

<i>Residences.</i>	<i>Stores, Factories, &c.</i>
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C. W. SCRANTON.	" " " " Cong. ave.
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G. L. FERRIS.	" " " Fair Haven.
H. P. FROST.	ENGLISH & MERSICK.
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CHAPTER VII

TELEPHONE BY-PRODUCTS AND SIDE LINES

WHEN TRANSCONTINENTAL TELEPHONE SERVICE WAS AN ACCOMPLISHED FACT, AMERICAN TELEPHONE ENGINEERS DID NOT SIT BACK AND FEEL THAT THEY HAD FINISHED EVERYTHING TO BE DONE. THEY CONTINUED TO IMPROVE THE QUALITY OF SPEECH TRANSMISSION; TO DEVISE APPARATUS FOR HANDLING AN INCREASING NUMBER OF CALLS, BOTH LOCAL AND LONG DISTANCE; AND TO MAKE FURTHER IMPROVEMENTS AND ECONOMIES THROUGHOUT THE PLANT. THEIR AIM WAS "A TELEPHONE SERVICE FOR THE NATION, FREE, SO FAR AS HUMANLY POSSIBLE, FROM IMPERFECTIONS, ERRORS OR DELAYS, AND ENABLING ANYONE, ANYWHERE, TO PICK UP A TELEPHONE AND TALK TO ANYONE ELSE, ANYWHERE ELSE, CLEARLY, QUICKLY, AND AT A REASONABLE COST."

IN ADDITION TO THIS, THERE WERE THE CHALLENGING POSSIBILITIES OF HERETOFORE UNDEVELOPED RADIOTELEPHONY. BOTH THE BELL SYSTEM AND INDEPENDENT MANUFACTURERS CONTINUE TO SPEND MILLIONS OF DOLLARS ANNUALLY FOR RESEARCH AND DEVELOPMENT.

THE MOST OUTSTANDING TELEPHONE RESEARCH ORGANIZATION IN THE WORLD IS THE BELL TELEPHONE LABORATORIES, IN NEW YORK CITY.¹ MANY HUNDREDS OF PHYSICISTS, CHEMISTS, ENGINEERS AND TECHNICIANS ARE CONTINUALLY EMPLOYED THERE ON THE MANIFOLD PROBLEMS OF PROVIDING "SATISFACTORY, ADEQUATE, DEPENDABLE AND ECONOMIC" TELEPHONE APPARATUS AND EQUIPMENT. THEIR EXPERIMENTS, ON A LARGE SCALE AND IN A WIDE RANGE OF SUBJECTS, PERTAINING PRIMARILY TO THE TRANSMISSION

of speech, have incidentally resulted in a quantity of ideas, devices, techniques and apparatus which may be called by-products. Broadly classified, the more important and interesting of these are: contributions to the theory of modern physics, mathematics and the science of metals; a science of speech; the world's most accurate clocks; and aids to health, safe flying, education and entertainment.

Because the telephone is a common carrier for what is perhaps man's most delicate commodity, namely, speech, the forces which it employs are almost infinitely minute, and among them the electron is of tremendous importance. From the research of telephone engineers in electronics have come results of revolutionary significance to modern physics. Dr. C. J. Davisson, one of the leaders in this field, worked for years, trying to devise a method and apparatus to substantiate the theory that the free and discrete electron of measurable charge and mass was essentially a group of waves limited in all directions. The experimental evidence which he finally succeeded in obtaining was considered so important as to win for him the Nobel Prize, in 1937.²

Dr. Herbert E. Ives, who has for many years been responsible for the Bell Laboratories electro-optical research and its development of telephoto and television apparatus, has also made a notable contribution to theoretical physics. The crucial experiment upon which Einstein's Special Theory of Relativity depended, although recognized as of fundamental importance, had commonly been described as beyond experimental feasibility. Dr. Ives, however, devised a method and apparatus for performing this experiment and won the acknowledgement of Professor Einstein.

Though carrying on no laboratory work himself, Dr.

Karl K. Darrow has made a most valuable contribution to physicists and their students, as well as to telephone engineers, by his lucid and carefully evaluated presentations of "advances in contemporary physics," made during a long term of years.

In the realm of mathematics and statistics, the works of Dr. T. C. Fry and Dr. W. A. Shewhart are well-known; Fry, for his development of the mathematical theory of probability, and Shewhart for his development of concepts and techniques for the application of mathematical statistics to the "economic control of quality of manufactured products."

To metallurgy, telephone research has contributed several new magnetic alloys of remarkable properties. Permalloy and permivar have come to be quite generally used in the communication field, in radio and telegraphy as well as telephony, for cable sheaths, relays and electromagnets, wherever it is desirable to have high magnetic permeability with very small currents of electricity. Vicalloy, a still newer contribution, can be made to hold more permanent magnetism than any commercial material. In addition it can be drawn and rolled, a property of decided advantage in many applications, which is not possessed by other important permanent magnet materials. Vicalloy has been rolled into tape one five-hundredth of an inch thick and one twentieth of an inch wide, several thousand feet of which were used for sound recording at the New York World's Fair. Shorter lengths are running constantly as endless loops in telephone weather announcing systems. It is thought that the properties of vicalloy mark it for a wide range of usefulness.

A method for sealing copper to glass, first devised by a

Bell Laboratories engineer, W. G. Housekeeper, facilitated the development of huge, water-cooled vacuum tubes such as are used in high-power radio transmission.

The most unique work in this field, however, is the metallography of Dr. Francis F. Lucas, who designed and had made for his telephone research, the most powerful microscope in the world, which magnifies up to sixty-nine hundred diameters—about twice as much as any standard equipment. With this microscope and almost superhuman patience, Dr. Lucas has become known to Oriental as well as to European specialists for his photomicrographs of the crystal structure of metals. His methods and results have been studied by industrial engineers the world over, and various United States government agencies have called upon Dr. Lucas to contribute, to their studies, the benefits of his apparatus and his experience. Not only cable sheath and contact metals, but also gun metal, and ship's hull plates, have come under his microscopic scrutiny; not only the fungus diseases of telephone poles, but also the social diseases of American citizens.³

Though Dr. Lucas did not invent the ultraviolet microscope, which is especially valuable in the study of living cells, until he invented techniques for working with it, it was practically useless. This type of microscope which depends for its operation on a source of light having a single, very short wave length beyond the visible range, is of advantage because this light can be focused on various planes within a living cell without sectioning and staining, and in the process destroying the life of the cell, as is necessary with other types of microscopes.

Since the transmission of speech is affected by the peculiarities of the human voice, members of the Bell Telephone

Laboratories have, for a number of years, been investigating the properties of speech: the frequency of occurrence, for instance, of various sounds; pitch and intensity differences between men's and women's voices; the distribution of energy due to accent and inflection; and the importance of these and other characteristics to intelligibility. More recently, the study has been extended to include the mechanism of speech production, especially the action of the vocal cords in the generation of voiced sounds.

By means of a mirror held at the back of the throat, and suitable lighting arrangements, it is easy to view the vocal cords in action; but as the motion of the cords is exceedingly rapid, little can be learned by simply viewing them. A very high speed motion picture camera was therefore used, which made it possible to take as many as four thousand photographs per second of rapidly vibrating vocal cords. When these pictures were viewed at about sixteen frames per second, the normal rate of motion picture projection, they made the cords' two hundred and fifty vibrations per second appear like only one, and the details of the motion could be clearly seen.

These "speech" photos suggest that, contrary to former theories of speech, the sound produced by the vocal cords would probably never be recognized as a vowel by a listener, if it were possible for him to hear it directly; it is the modification of this basic sound radiated into the air from the mouth, which is what we know as speech. This is a subject of special interest to the medical profession and vocal teachers, as well as to telephone engineers.

Because in their problems of electrical communication, telephone engineers are concerned with frequencies ranging from less than one cycle to a hundred million or more

cycles per second, and with measuring frequencies with an accuracy approaching one part in a million, they have had to devise means for generating and checking such currents. Little wafers of quartz, it was known, have piezoelectric properties which make them vibrate when an alternating current is applied across their face. Though of electric origin, this vibration is mechanical and its fundamental frequency depends upon the size, density and elasticity of the piece of quartz. Such crystal wafers may, therefore, be inserted in suitable electrical circuits, and made to control the frequency of current fluctuations in the circuit with extreme accuracy. The crystal's vibrations are so precise that they can be harnessed to provide the accurate time intervals for clocks and other electrical mechanisms that have to be operated at a fixed rate.

As a matter of fact, if your electric clock is "plugged-in" on current generated in one of the huge power plants of New York State, it is probably controlled by the vibrations of one of these thin wafers of quartz crystal kept at the Bell Telephone Laboratories. Not only yours and millions of other clocks, but also millions of pounds of giant generators and motors in power plants, factories, office buildings, hotels and apartment houses, obey the beat of this tiny marshal, when they work on an alternating current of exactly sixty cycles a second.

And this is not all the little quartz wafer does. Beside setting the pace for electrical machinery, and making the cheapest electric clocks keep time as accurately as the finest chronometers of former days, it is used as a reference standard, against which the assigned frequencies of radio broadcasting stations are checked, to make sure that a selected station will "stay put" in its place on your dial.

To symbolize the importance of time measurement in the engineering and operation of the telephone plant, the American Telephone and Telegraph Company features a "telephone clock" in one of the large windows of its headquarters at 195 Broadway, New York. The clock's accuracy is emphasized by a seconds dial, nearly three feet in diameter, outside, instead of inside, the minute and hour dial. The movement of the long red second hand is what attracts the eye, for the minute and hour hands are short and move slowly in smaller orbits. The element which takes the place of the pendulum in the usual precision clock, is again the little vibrating quartz crystal. Its performance is checked frequently and precisely with time signals from the naval radio station, Arlington, and has been found to be accurate to a hundredth of a second a day. Eight companion clocks in the same window are adjusted to show the time in various other cities throughout the world.

In the early nineteen twenties, when vacuum tube amplifiers were beginning to prove their possibilities, people tried to use them for all sorts of things. Several doctors and telephone engineers got together and developed an electrical stethoscope for magnifying the sound of heart beats. This was found to be very useful in teaching medical students to recognize the peculiarities of sound associated with various heart diseases, and to distinguish the faint ticking of fetal hearts. It was even used by a doctor in Chicago to diagnose the ailment of a patient in New York, over the telephone, but this was only for demonstration purposes; so many other factors enter into a diagnosis that this method would not be acceptable as general practice.

Following the development of the electrical stethoscope, the doctors and telephone engineers who had worked on it,

enlisted the cooperation of the Columbia Phonograph Company, for making records of the heart and chest sounds, typical of various stages of health and disease. These records were to be used as a sort of reference library by students and practitioners anywhere in the world, and to serve also as standards with which to compare the heart sounds of patients.

More recently an "industrial stethoscope" has been developed. This device measures the intensity of sound at any preselected pitch and turns a deaf ear to all other factory noises. It is used for detecting flaws in running machinery, such as electrical refrigerator units, roller bearings and automobile generators; and also for detecting pellets of lead solder in canned goods moving along the production line.

Telephone engineers used their science of speech, also, for manufacturing a by-product, which happily the world has little use for. In the United States there are only several hundred people who, because of malignant disease, have had their larynx, or "voice box," removed by surgical operation. For these few unfortunates, however, an artificial larynx was developed so that they might still be able to speak, and we suppose, incidentally, telephone. This remarkable device provides a new passage for the air stream from the lungs to the mouth. To convert this steady current of air into a pulsating sound wave, in place of the vocal cords, which no longer vibrate, there is a thin metal reed which is free to vibrate inside a spool-like box. One end of an artificial larynx is connected, by means of a rubber tube and pad, to the windpipe opening, made by the operating surgeon on the front of the user's neck; the outlet tube at the other end of the artificial larynx is intro-

duced into the mouth of the speaker who must go through the ordinary motions of speaking, with his tongue, lips and jaw so as to manufacture, out of the basic sound produced by the artificial larynx, the voiced speech sounds. An adjustment is provided for changing the pitch of the larynx, so that it can be used by either men or women. By continual practice, people can become very proficient at speaking with an artificial larynx, and so be restored to the happiness and useful normal activities that attend the power of speech.

Since telephones must have receivers as well as transmitters, the characteristics of hearing have also been of vital concern to telephone engineers. One of the first problems they encountered was that of accurately measuring hearing. The tuning fork and watch-tick methods employed by doctors, were quite unsatisfactory for testing people with normal hearing. Another method was therefore worked out whereby a person listened with a telephone receiver for a tone that was just audible to him. As the pitch and intensity of the sound coming through the receiver could be controlled and measured, the hearing of an individual could thus be measured in an absolute sense as well as with respect to normal. As the results of this work became generally known, a demand for methods and equipment began coming from hospitals, otologists and others interested in hearing. Dr. Harvey Fletcher, director of this research, showed marked public spirit in his readiness to cooperate.

Audiometers, for measuring hearing, were devised and put on the market, and chart forms, called audiograms, were worked out for scientifically recording the results of hearing tests. These came to be used very generally by doc-

tors, in clinics and hospitals, and in research on hearing. For diagnostic purposes, two kinds of receivers were developed, one of the usual air conduction kind to direct sound through the outer ear to the drum and ossicles, and another to communicate sound vibrations via the skull bone in back of the ear.

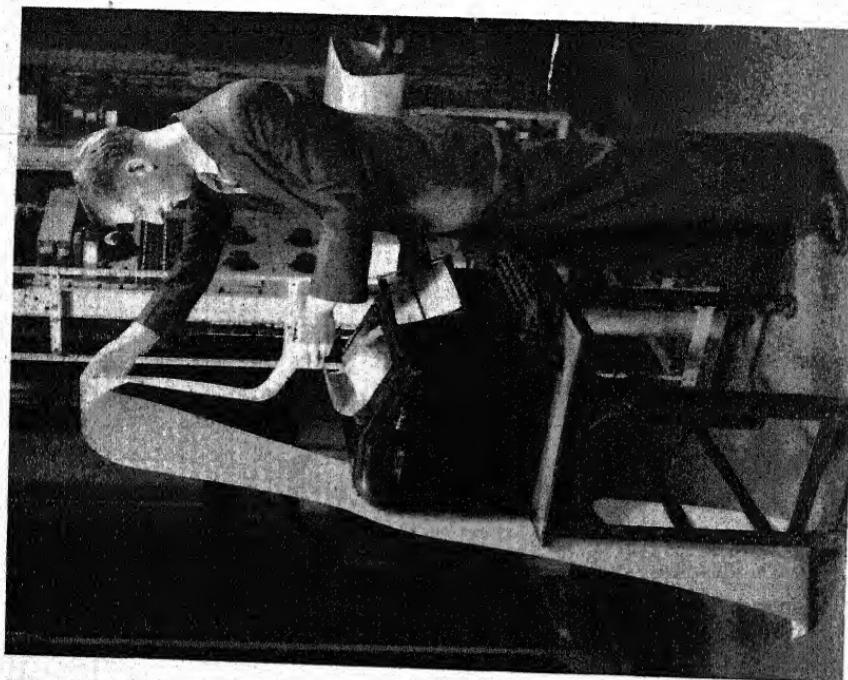
Shortly after the research work was initiated, considerable interest was awakened in the hearing of school children. From national surveys it was estimated that almost two million school children were partially deaf. It was harder for them to learn and, later on, it would be harder for them to earn. If it were only possible to pick out all the children with defective hearing, and give them the special attention which they needed, much social and economic waste might be avoided. This time it was with the American Federation of Leagues for the Hard of Hearing that telephone engineers worked.

Methods, equipment and record sheets were soon ready for testing groups of as many as forty children from any school grade. The procedure was something like this. The children went to a classroom where everything was in readiness for the test. Each was given a telephone receiver and got it properly adjusted to his head. Then someone told them that they were about to hear numbers called, "first by a woman, and then by a man, who seems to be moving farther and farther away, so that the sounds grow weaker and weaker." They were asked to write as many of these numbers as they could hear. A phonograph was then started and the children heard: "You are going to have your hearing tested. Write the numbers which you hear in column one." Then the numbers were played by the phonograph, in gradually decreasing loudness.



Hearing test

Telesphoto sending apparatus



A day's program order teletyped to radio networks

About ten per cent of the children thus tested, it was found, were acoustically handicapped; examination of school records disclosed the fact that such children repeated three times as many courses as children with normal hearing. The League for the Hard of Hearing made a special drive to interest the nation in making the detection, care and education of deafened children, a matter of school routine. This movement spread very rapidly, especially in cities, and as far away as Honolulu and Capetown. It has been found that by medical treatment, lip reading instruction, the use of hearing aids and more favorable seatings, these repetitions can be cut at least in half. This represents a financial saving estimated at between \$3600 and \$12,600 per 1000 children, no mean consideration from the taxpayer's point of view. Better than that, however, the hearing of probably more than a million children is now tested annually, and case reports abound in instances of incipient infections discovered in time to correct them, and "dull" children turning out to be "bright." Work of this sort being done in Muskogee, Oklahoma, New Rochelle, New York, and the Iowa State University is especially notable.

From tests made on our adult population, it has been estimated that every tenth grown-up, likewise, has his hearing sufficiently impaired to inconvenience him in ordinary pursuits. For such persons, many kinds of hearing aids, based on telephone principles, have been made available, and continually improved. Whereas some fifteen or twenty years ago, such devices usually weighed upwards of ten pounds and were very bulky to carry around, more recent models weigh no more than a pound and a half, and many persons can conceal completely the fact that one is being

worn.⁴ A program of public education is now going on which is aimed to make the hearing aid as acceptable and as socially inconspicuous as eye-glasses have become.

Special telephone facilities are also available for subscribers whose hearing is impaired; lower pitched, more powerful bells and gongs or visual signals, and a special amplifier for controlling the volume of sound received. Many churches, theatres and public halls are also provided with special aids for those who have difficulty in hearing.

When it was found that the background noise in an average city office was responsible for considerable impairment of hearing, and accompanying nervous strain and decreased working efficiency, telephone engineers developed meters and methods for gathering scientific evidence against the city's noise makers. Noise Abatement Commissions, the National Electric Light Association and the American Telephone and Telegraph Company all made surveys in buildings and out-of-doors, to determine which were the worst offenders, which were unavoidable and which could be soft-pedalled, by an informed public. Various local ordinances against noise, resulted from these surveys.

Action was directed chiefly against motorists who used their horns more than was necessary. Many such offenders were arrested and fined, but in general the police found it too bothersome to enforce the antinoise laws rigidly. A reporter from a big city daily, in need of feature story material, decided, after several thousand dollars in fines for this offense had been collected, to go and remeasure the noise at a corner included in the official survey, to see how effective noise abatement efforts had been. "Good for the city's coffers, but no help to the citizens' nerves," he re-

ported, "the corner was two or three decibels noisier than it was before."

From the time during World War I, when they developed the system of two-way radiotelephony for communication between ground stations and planes in the air, telephone engineers have been interested in aids to safe flying. The Bell Telephone Laboratories, for several years, maintained a "flying laboratory" for experimenting with various aeronautical instruments of their invention.

One of these was the terrain clearance indicator, developed in response to a consistent demand from flying personnel for a positive type of altitude indication above ground. Since the early days of aviation, the altimeter on board all aircraft has been of the aneroid barometer type, actuated by pressure of the atmosphere, and for obvious reasons, unless carefully calibrated and set for both the ground elevation and atmospheric pressure at a particular point, would not be accurate for that point.

The terrain clearance indicator, as the name suggests, by the movement of a needle across the meter dial, gives the height of the plane over what is immediately below, be it water, land or even buildings. The operating principle of the terrain clearance indicator is the measurement of time of transit of radio waves of changing frequencies "bounced" from the plane to the ground and back again.

The instrument has been demonstrated to many groups interested in air navigation and the principle of operation has been accepted and proved. It is expected that as larger airplanes become available the present objections to the current requirements of the instrument and to its weight (it weighs as much as half a passenger) will be largely eliminated, and it will be put into general use.

Another aid to safe flying, developed as a by-product of telephone research, was a device for guiding lost planes. This direction finder makes it possible for the pilot of a sky liner completely wrapped in a blanket of fog, if he has lost his bearings, to send out a call by radiotelephone, to the nearest ground stations. Operators at these points, on receiving the call, simultaneously, read bearings as given by a spot of light on a cathode-ray tube screen marked with a compass rose. These bearings are then relayed by radiotelephone to a central point where the actual position of the plane is quickly calculated and radioed back to the pilot, so that he may head for a landing field and be guided in, if he wishes, by the operator who knows his position from watching the tiny speck of light moving on the frosted glass. Since this new direction finder is still in the developmental stage, the Civil Aeronautics Authority has made only experimental installations in a limited area, and, at the moment, calls are received only at New York, Washington and Pittsburgh airports.

At intervals of about a hundred miles along our regular air routes, the Civil Aeronautics Authority and transport companies have established radio stations, each with its own characteristic wave length, which planes may tune in on as the need arises. To save busy pilots the added task of retuning their receivers every time they pass from the operating area of one wave length to that of another, the Bell Telephone Laboratories developed still another remarkable device, by which pressing a button tunes the pilot's receiver to any one of thirty ground stations. This device is just coming into general use.

Their years of studying and transporting such a delicate intangible thing as sound, the intensive concentration they

have devoted to it, the patient, oft-repeated and exact analysis, far from filling telephone engineers with the contempt which is said to attend familiarity, have, rather, inspired them with the highest esteem. They have spent almost incredible intellectual energy on converting sound waves to electrical ones without weakening or distortion, conveying these through varying distances, and reconverting them to sound again with perfect fidelity. Their greatest achievements in this are enjoyed not so much in commercial communication as in art and entertainment. When telephone engineers directed their efforts to storing up treasures of music, so that anyone, at any time, might enjoy them in all their natural beauty, they made perhaps their most heart-warming contribution to mankind.

Before telephone engineers tackled the problems of recording and reproducing music, Thomas Edison had developed the phonograph. Like the early telephone, however, the early phonograph handled only a limited portion of the component tones of speech, and these it reproduced with raucous distortion. Since the phonograph method of recording and reproducing depended on the power of sound waves themselves, its possibilities for improvement were limited; it could not respond to the more delicate tones of speech or music. By 1920, the mechanical phonograph was about as good as it could ever be. Though its best efforts still sounded rasping and unnatural, people had grown more or less accustomed and tolerant; its popularity was soon to be superseded, however, by that of radio broadcasting.

By this time, of course, the telephone transmitter had been carefully cultivated into a special variety called the microphone; the receiver into the loudspeaker. If a micro-

phone were set to pick up sound, it converted into waves of electricity in wires, what a one-eared listener at the same spot would have heard. For phonographic purposes, this electrical current could be amplified to drive a graver, which cut sound wave patterns on a disc very faithfully. A needle following the wavy lines of such a record, could create electrical vibrations, which in turn could be converted to sound again by a high-quality loudspeaker.

The first public showing of this application of telephonic technique to the phonograph art was made in New Haven, Connecticut, in 1922. The phonograph, with its electric amplifier and loudspeaker, reproduced from electrically cut records a lecture made to accompany a silent motion picture. The enthusiastic response which this demonstration aroused, indicated some of the future possibilities for sound motion pictures and encouraged development of them.

Though a feeling then prevailed that the public would be unwilling to buy electric reproducing equipment, the process for making electrically cut records commercially was licensed, early in 1925, to the Columbia Phonograph Company and to the Victor Talking Machine Company for production here and in England, and a much improved telephone by-product called the "orthophonic" phonograph was put on the market by the Victor Company. No longer was it necessary to group artists in unusual positions close to a horn on the recording mechanism, or to attach pipes to violins. A microphone, out in front of an orchestra with its usual seating and instruments, could pick up the natural quality of the music. It was quite the thing in those days to give concerts with both the artist, in person, and a reproducing system on the platform, and then ask the audience to close their eyes and try to tell when

they were hearing the artist's voice directly, and when via the machine. The fine quality of orthophonic reproduction brought great joy to music lovers and added to their number many new and appreciative listeners who had not been privileged to become familiar with good music before.

As a result of the sound motion picture demonstration, synchronizing equipment was developed for playing electrically cut records of speech in exact time with moving pictures. This was licensed to Warner Brothers who brought out the Vitaphone version of *Don Juan* in 1926, and relegated silent movies to the realm of the past. When film broke and had to be patched, however, difficulties arose with this method; film and disc were no longer in perfect synchronization; the heroine was apt to be opening her mouth in the pictures while a booming bass came from the record; still worse the villain might fall before the hero's shot was heard.

Almost simultaneously with this method, a photographic method of recording was also being developed. By this photographic method, speech-bearing electric currents were made to operate a shutter, or light-valve. This controlled the amount of light falling on a moving film, and in this way recorded on the film, in variations of photographic density, the variations in the speech-bearing current. For reproduction, the film was run between a lamp and a photoelectric cell, which originated a current to be converted into sound again by a loudspeaker.

By the summer of 1928, most of the large producers of motion pictures in the United States were producing "talkies" by one of these methods. The film method was developed commercially as the Western Electric Noiseless

Recording System, which is now used all over the world in places large and small where people go to the movies. So quickly and fully accustomed to the talking feature have movie-goers become, that they don't even mention "talkies" any more ; they simply take it for granted.

But telephone engineers carried on their research in sound reproduction still further. Their most recent and remarkable achievement is stereophonic recording. Though this method, at the moment, is more suitable for concert hall than for domestic use, music recorded in this way is to enter the home by way of frequency modulation broadcasts. Stereophonic recording was introduced to the world with the cooperation of Leopold Stokowski and the Philadelphia Orchestra, of the Tabernacle Choir and organists in Salt Lake City, and of Paul Robeson and other artists. After their music or drama was recorded, these artists were allowed to hear it reproduced as it had been played originally. If he was not entirely satisfied, the conductor or artist was then able to vary the recorded volume and to change the tonal color to suit his taste ; he could soften it to the faintest pianissimo, he could amplify it to a volume ten times that of any orchestra without at all altering its tone quality ; or he might choose to augment or reduce the high or low pitches independently. While he was thus enhancing the music or drama, which he had himself directed or performed, his interpretation was being re-recorded on film as a permanent record. A demonstration to show the full capabilities of this system was given at Carnegie Hall in New York. Choral numbers, vocal solos, organ, drama and grand opera, all were reproduced. What critics thought of this performance, is expressed in a quotation from the *New York World Telegram* of April 10, 1940 :

A new high in the science of recorded sound was reached at Carnegie Hall last night when the Bell Telephone Laboratories demonstrated their latest results in stereophonic recordings, with emphasis on the problems of "position" and "enhanced" music.

When the lights went out, all one saw was a gossamer veil hung across the stage, with a soft red glow playing on it. Then things began to happen. An eerie flute sounded thinly from the distance; a crowd bellowed thunderously; horses galloped by; thunder rumbled; a man talked as he walked from one end of the stage to the other. Then the whole width, breadth, and depth of a symphony orchestra spread out its wings and went into action.

It sounded real, spread out in space. The full depth of the stage seemed crowded with spatially distributed sound. But it all came from a set of sound boxes and horns, each functioning separately and in unison in a broad, electrically controlled dynamic scheme. Dogged research in electricity, acoustics, dynamics had chalked up one more miracle—spread-out sound, coming straight from the source with no hint of crowding.

Mr. Stokowski's orchestra sounded very much its multiple self, and with the "enhancing" of between-the-lines nuances, even more than its flesh-and-blood self.

Drums were at one end, flutes at another, and in between one "heard" other instruments clear across the stage. Shading emerged beautifully, solo passages rang out brilliantly. There was no blurring, no congestion. Pianissimi were the merest hush and fortissimi had the impact of a cannonade.

The trick of giving orchestral music "position" in recordings and weaving in nuances between nuances is now a perfected fact.

Not satisfied with the faithful recording and reproduction of speech, telephone engineers, as visitors to the San Francisco and New York World's Fairs in 1939 and 1940 will remember, even went so far as to create it. When the Emperor of Brazil after listening to Bell's telephone at

the Philadelphia Centennial Exposition exclaimed, "My God, it talks!" he somewhat overstated the facts; for the telephone did not talk, it carried talk.

Pedro, the Voder, at the more recent Fairs, however, was a machine that could actually be made to create speech. Reminiscent of an old-fashioned organ in appearance, this device had electrical mechanisms for producing and controlling all the essential sounds of human speech. Except for its keys, it was built entirely of apparatus in everyday telephone service. Learning to operate it, required considerable practice, but not as much time as it takes a human being to learn to talk. It was designed, not with any idea as to a commercial future, but as the derivation of its name, Voice Operation DEMonstratoR, implies, as an interesting and entertaining educational exhibit. Many people said it made them much more keenly aware of the wonders of their own speech mechanisms.

The Bell Telephone Laboratories were, also, among the television pioneers. Although their only part in connection with recent television promotion has been the provision of adequate wire facilities for handling the wide bands of frequencies which it requires,⁵ as far back as 1927, they staged the first public demonstration of television that really involved considerable distance. This was transmitted over telephone wire circuits between Washington, D. C. and New York City, and by radio from New York City and a laboratory in Whippany, New Jersey. At this time it was possible to televise only a small area, such as the figure of a person sitting at a telephone; but the next year demonstrations were given of large outdoor scenes and activities, and, within another twelve months, under the direc-

tion of Dr. Herbert E. Ives, television was shown in color. Early in 1930, television phone booths were installed at the American Telephone and Telegraph Headquarters and operated a whole year, so that the public might become acquainted with television phone calls, and give some indication as to what demand there might be for regular commercial television phone service. Soon after this, regular telecast programs were scheduled in England, and receiving sets were sold there for household use, but the A. T. and T. was not interested in television from the entertainment angle.

For various reasons, both technical and economic, it was not until the opening of the New York World's Fair, that television was introduced on a commercial basis to the American public, by the Radio Corporation of America and the National Broadcasting Company. At that time from their antenna atop the Empire State Building, it was possible to telecast only within a fifty mile radius of New York City, but improvements are being made continually, and a minimum of ten hours a week of televised programs are now being given from the National Broadcasting Company studios, and from mobile units which cover sports, spectacles and news events in various places.

Besides the strictly voice communication facilities of the telephone, there have grown up in this country several associated services, which may be called side lines. One of the three most highly developed and widely promoted of these side lines of the telephone business is the teletype-writer service.⁶ Originally known as the printing telegraph, the teletypewriter has long been of recognized utility to news associations. It is now one of the vital

instruments of the news-gathering industry; the steady drumming of its tireless keys is one of the characteristic motifs of the busy newsroom.

Like telephones, teletypewriters have two separate mechanisms for transmitting and receiving. When any key of a sending machine is struck, it sends over the wire to the receiver (or printing machine) at the other end, distinctive electrical impulses which select the corresponding type-bar on the receiver and cause it to strike. Thus words are sped fast and far, and appear on one or many distant pages, at a speed of about sixty a minute. During a busy day, long rows of teletypewriters deliver to more than 1600 clients throughout the United States, more than a million words of news from the three great services, Associated Press, United Press and International News Service. About 7000 teletypewriters and 500,000 miles of connecting wire networks are in service for these three press associations. The news magazine, *Time*, uses the teletypewriter to convey its weekly copy from the New York editorial office to printing plants in both Chicago and Philadelphia, where teletypesetters automatically set it into type, and make possible the production of identical copies for both Western and Eastern subscribers, with substantial speed-up in delivery.

So valuable did the teletypewriter prove itself in the service of the press that it was soon adopted by the police, airport officials, bankers and businessmen. It afforded them an ever ready means of recorded communication, without the necessity of having a person on hand to answer and take notes. New York offices did not have to keep employees on the job until eight in the evening, when, owing to time differences, the San Francisco business day

was over; nor did someone in the Seattle office have to come in at seven in the morning, to be on hand for a possible call from Chicago headquarters at nine. Such messages were typed out simultaneously by receiving machines in any or all plants, branches, or departments of the organization, and available whenever it was convenient for the proper persons to handle them. When teletype-writers first began to be used by others than the press it was still on a private basis. Each organization having a number of teletypewriters had its own connecting system.

As the utility of the teletypewriter was further demonstrated, however, a teletypewriter exchange service, TWX for short, was established. Subscribers to this service are provided with sending and receiving machines, and facilities for being connected quickly with other TWX subscribers, in much the same way that telephone subscribers are connected. The national TWX directory now lists upward of twelve thousand names of business organizations in about fifteen hundred cities and towns.

Business executives use it to supplement telephone facilities in their supervision of scattered units, also, because the teletypewriter not only provides a record, but can be made to do "form-writing," of customers' orders, production reports, purchase requisitions and such, between distant points, with several copies for the various departments concerned.

With its printed record, its duplicate copies, its ability to receive messages at unattended stations, its secrecy and its power to communicate simultaneously with many points over a wide area, the teletypewriter offers features of special value to law enforcement bodies. Accordingly, it forms the basic system in modern police communication networks.

From a single system, installed by a group of Connecticut municipalities, in 1927, police teletypewriter systems have grown so as to cover the additional states of New York, New Jersey, Massachusetts, Rhode Island and Pennsylvania, with connections to parts of Delaware and New Hampshire. A state-wide system also is in service for the police in California, and other states have less extensive systems. Many metropolitan cities and counties, some in states not having state-wide systems, have also equipped their police with teletypewriter connections between headquarters and precincts or outlying communities.

The "Eight-State Police Teletypewriter System," often mentioned in the news, is, in effect, a gigantic network, linking together with the various state police, the police forces of 350 communities. It serves day and night to protect 35,000,000 people throughout 125,000 square miles, a densely populated area larger than either Great Britain or Italy.

Because the automobile is used so extensively in connection with crime, the Eight-State System also connects with motor vehicle bureaus so that the police are able to make rapid checks on car and driver licenses. The police of Buffalo, New York, for example, have no difficulty in determining, from the motor vehicle bureau at Hartford, Connecticut, that an abandoned Connecticut car has previously been reported as stolen or that a driver, suspected of operating a stolen car, has a police record of convictions for car thefts.

Teletypewriter connections to the state bureaus of criminal identification also flash to the police thousands of clues through which criminals are identified, apprehended and

eventually convicted. Even fingerprint information may be transmitted by teletypewriter. A system of classification has been worked out with letters and numerals describing the characteristic form and number of the lines in the print of each finger; for example, U and R indicate, respectively, the fingerprint "ridges" flowing in the direction of the ulnar and radial bones of the arm, while the figures designate the number of these ridges which may be counted between certain reference points in the print. Anyone familiar with the system can readily tell whether or not a suspect's fingerprints are identical with those described by the teletype message:

	THUMB	INDEX	MIDDLE	RING	LITTLE
Right	U-11	U-9	U-12	R-8	U-10
Left	R-5	R-10	U-12	R-11	U-9

The number of alarms and messages handled each year over the teletypewriter systems of the eight-state network increased sharply as the various forces learned how effective it was in their work. The New York State Police System, for example, handles annually more than three hundred thousand alarms, reports and messages. Tangible results are shown in figures supplied by the New Jersey State Police. In one year, criminals were apprehended or stolen property was recovered in 1376 cases, through information sent over the police teletypewriter system in that state.

Police officials feel that the scarcity of dramatic crimes may be due somewhat to the preventive factor present in modern police communication systems, and are convinced that the knowledge of the existence of modern communication equipment in a given area, acts as a crime deterrent.

Members of the New York Hotel Association say that, since they have been displaying at their cashier's window, a metal sign reading, "This hotel protected by New York State police teletypewriter system," they have substantially cut their losses from "skippers," who leave without paying their bills, and "charmers," who pass worthless checks. The *Worcester Telegram* commented recently on the capture of a gunman: "A bullet killed him, but radio and teletype and telephone had already doomed him."

Though most police teletypewriter systems are set up on a private line basis, the Federal Bureau of Investigation of the U. S. Department of Justice uses TWX service. There are seven machines in the headquarters office at Washington, two each in the New York, Chicago and Philadelphia offices, and one each in the remaining field offices throughout the country.

When the Bureau's Director, J. Edgar Hoover, or a member of his staff in Washington, wants to communicate with the field in which are operating 500 specially trained and famous "G-men," Bell System operators, following a carefully formulated plan, swiftly set up a TWX conference circuit, linking the Washington office with every field office desired, and the message from headquarters begins clicking off in all of them simultaneously.

The teletypewriter also enables police to perform many additional services of a noncriminal nature for the public. In one such case from the records of the police, a baby's life was saved from poisoning. The police alarm, teletyped in all directions, was as follows:

8-State Alarm—please stop a Chevrolet car license G—
W— Motor 8—. Car is occupied by a man named
C. E. B— with his wife and baby. They took a bottle

supposed to be medicine, contents of which was to be administered to the baby. The bottle they have contains poison—1 per cent atropine sulphate. Poison bottle was taken by them by mistake. Please make every effort to stop this car and warn them of danger. If supposed medicine has already been administered to the baby use any emetic as antidote.

An hour after this alarm had been sent out, a patrol nearly a hundred miles distant from where the error had been made, recognized the car. The "cancellation" which followed said, "Baby out of danger, only one small dose of poison administered."

The teletypewriter has also been an important contributing factor to the rapid development of air transportation in this country; to the increased route mileage and miles flown, the increased number of passengers, the regularity of schedules maintained, and the number of passenger-miles flown without accidents. Our principal airways were established largely through Federal aid, and in addition to marking and lighting airways, the Airways Division of the Department of Commerce provided radiotelephone stations at approximately hundred mile intervals, and contracted for twenty-four-hour teletypewriter service along the main airways, chiefly for the purpose of transmitting weather reports. Teletypewriters seem ideally fitted for this service. Complete records, in code, of weather conditions along each route appear on the teletypewriter tape at individual stations, and at hourly intervals beacon signals are interrupted for the broadcasting of these reports to pilots in the air. These weather information facilities are made available without cost to aircraft operating companies and others.

Transport companies use private wire facilities for transmitting information pertaining to the operation of their

own lines, such as plane dispatching, passenger reservations, amount of express and mail carried, connections and arrangements to be made. Plane movements, including reports of position in flight, are also transmitted by teletypewriter connections between various ground stations.

As early as 1925, the Bell System had facilities for transmitting pictures as well as words; photographs of criminals or missing persons, for example, or drawings of mechanical devices, weather or military maps, autographed letters, legal papers, signatures, real estate plots, advertising layouts, movie publicity "stills" and so forth. For five or six years they offered these telephoto facilities on a subscriber basis, but the demand was not sufficient to warrant their continuance. Several years later, however, newspaper men who felt with the Chinese sage that "One picture is worth 10,000 words" became actively interested in telephotography. At that time it was impossible, at least for newspapers distant from the scene, to publish pictures until hours, or even days, afterwards. The photographer had to bring them back to his home office to be copied and distributed by air mail or special messengers. Soon, however, each press association had its own telephotograph apparatus patterned after that developed in the Bell Telephone Laboratories; pictures were speeding over the telephone wires directly on the heels of the news, in fewer minutes than the old ways took hours.

The Wirephoto service of the Associated Press, for example, works something like this:

An operator in its Rockefeller Center headquarters goes to a control panel and speaks into a telephone. From out of the loud-speakers in fifty or more Wirephoto stations scattered over the country comes his announcement:

"New York calling all points. Are you ready?"

"Ready," pipes Chicago.

"Ready," drawls the man in Atlanta.

"All set here," from San Francisco.

"Okay, New York," from Syracuse.

When roll call is completed, the circuit is open for business. Miami may have a picture to send, or Washington, or Seattle. They report what they have, and New York directs who will send what and when. Then they're off, and in eight minutes, in any one, or all, of the stations on the network, attendants pick similar cylinders off their receiving machines and hurry into darkrooms. Another few minutes and the finished print, caption and all, is on the editor's desk.

For events which happen "off the main line," or which, like prize fights, offer a good series of pictures, portable telephoto apparatus has been devised. An International News photographer, for example, will rush to a small town where, he has just been tipped off, the wedding of a couple of movie stars is to take place, get himself a room with bath and telephone in the local hotel, go out and get his "shots" of the bride and groom, dash back to develop and enlarge them in the bathroom, and transmit them to headquarters by a device which is simply coupled to the telephone. His picture rolled onto the cylinder of his Sound Photo transceiver, like a label around an extra long tin can, is scanned by a tiny beam of light, one one-hundredth of an inch square. The light and shadow of the picture is automatically interpreted into a continuous whistle, which becomes instantaneously loud for white, softer for intermediate tones and hardly audible for black. This whistle is sent over an ordinary telephone, just as a voice might be, and, at the

receiving end, is reconverted to a tiny beam of light which reproduces the picture on a photographic negative.

On Christmas Eve in 1906, radio operators on ships at sea caught "deedadeedadeedadee," the general inquiry Morse code call which they were used to receiving; and then to their utter amazement, heard on their instruments: a woman singing, a violin solo and, in conclusion a man's voice asking all who heard, to write to R. A. Fessenden, Brant Rock, Massachusetts. This was the world's first radio broadcast.⁷

Other scientists in Austria, France, Italy, Germany and England, as well as in the United States, were also trying to transmit speech by radio. In 1915, it became possible to do this all the way from Arlington, Virginia, to the Eiffel Tower in Paris, and to Honolulu in the Pacific. Though these transmissions were entirely experimental and very uncertain in quality, the results were encouraging, and research went on apace in various laboratories.

Very soon, not only scientists and research workers, but also little boys and their fathers were stringing up antennas on the roofs of their homes and tinkering with "cat's whiskers" and crystal detectors. At first, radio was thought of, chiefly, as a means of providing communication facilities to ships at sea, and other points difficult to reach by wire or cable; but it soon became apparent that radio-telephony was ideally suited for the broadcasting of entertainment, and educational or informative programs.

Before the actual development of radio broadcasting as we know it today, however, much telephone broadcasting was being done with headsets and so-called public address systems. At the first broadcast of this sort, in 1912, several hundred Yale University Alumni, at a dinner in Chi-

cago, listened with receivers held to their ears, while their President spoke to them from New Haven, Connecticut. In 1915, demonstrations of the new transcontinental telephone service were given in this way. One such demonstration was broadcast by individual headset receivers to over three thousand people in New York City, and about a thousand each in Philadelphia, Baltimore and San Francisco. By 1916, the microphone and the loudspeaker were beginning to show promise; twelve thousand people, in the Velodrome in Newark, New Jersey, heard announcements conveyed over eighteen loudspeakers. When "the boys came home" in 1919, Park Avenue, New York, was transformed into "Victory Way" with a hundred and thirteen loudspeakers blaring music and speeches. In 1920, both the Republican and Democratic Conventions had their microphones and loudspeakers. The culmination of this type of broadcast was the ceremony for the burial of the Unknown Soldier, on Armistice Day, 1921. It was estimated that this program was heard by 100,000 people in Washington, 30,000 in New York and 20,000 in San Francisco. The size of an audience was no longer limited by the range of a speaker's voice, or the seating capacity of a music hall.

Broadcasting was an essentially new type of communication; there had never been anything like it before, and it created many problems besides technical ones. Since any person could make his own receiving set and listen to programs from all stations, the question of who should pay the costs was a perplexing one. Obviously some arrangement had to be made also to prevent programs, broadcast from different stations, from interfering with each other and rendering futile the best efforts of both. What

kind of entertainment or educational programs should be given? And how was the cooperation of musicians and speakers to be enlisted? Should any one who wished, be allowed to use the air in this way? How many and which hours of the day did people like to listen? How many people would listen at one time, where would they be? How permanent would be this interest in broadcasting? Every schoolboy nowadays knows the answers to these questions.

The first of the broadcasting stations that have survived until the present, was KDKA, Pittsburgh. On Election Night, November 2, 1920, this station presented its first regular program which consisted of a running account of returns of the presidential race between Cox and Harding.

Other broadcasting stations were opened at various points throughout the country. Originally, their programs consisted entirely of music, talks, or other forms of entertainment from within the studio of the broadcasting station itself. Somewhat later, some of the stations began to go to more remote points to pick up programs of one form or another: music by hotel orchestras, church services, football games and other sporting events, political conventions and similar public gatherings. For this purpose, wire circuits were employed from the point of origin to the radio broadcasting stations.

It was at this point that the telephone companies first entered the field of radio broadcasting. It would have been technically possible, of course, for each broadcasting station to install its own circuits from the point where the program originated to its studio, but this would have proved unduly expensive; usually local telephone compa-

nies already had circuits running to the points of origin, as well as to the broadcasting studios.

Obviously, also, much that had been learned during the development of our nation-wide telephone system would be useful in the development of broadcasting: the characteristics of sound, and particularly of speech sounds; the best methods of transforming these sounds into electrical impulses and transmitting them clearly over greater and greater distances; apparatus for amplifying telephone currents which had lost strength while traveling over these long stretches of wire; this, and a vast amount of other information which had been accumulated during more than half a century of telephone development.

In 1921, the Bell System established an experimental radiotelephone station which later developed into Station WEAF. This was done not only for continuing technical research, but also for finding out what the reaction of the public would be to high quality programs. When broadcasting was felt to have gone beyond the experimental stage, WEAF was sold to the Radio Corporation of America, which later transferred it to the National Broadcasting Company.

Though the public seemed satisfied with their homemade receivers, and with the programs that came to them part way over regular telephone lines, it was obvious to those working with network broadcasting that listeners eventually would become more critical, and that the quality of transmission and reception would have to be improved. Just as telegraph lines had been found unsuitable for telephone use in the early days, so the system which worked very well in transmitting speech was found totally inade-

quate for high quality transmission of music.⁸ Special circuits were therefore designed and operated for the first time, in 1923, between South Dartmouth, Massachusetts, and New York City. With this hookup, modern chain or network broadcasting began.⁹

The second National Defense Day Program, on July 4, 1925, found suitable telephone wires uniting radio stations from coast to coast, and by the time of the first Tunney-Dempsey bout, in 1927, radio's reach had been extended to the limits of the country on the north and south as well. It was this linking of broadcasting stations by a far-reaching web of special telephone cables and wires that made the radio what it is in America today. In no other way could the many broadcasting stations in remote small cities have tapped the supply of talent which they give their listeners every day. Without these facilities, the selection of programs available in large cities also would be very definitely limited. Without them, football games and other sporting events, the proceedings of political conventions and other public gatherings, or the voice of a president, speaking from his study in the White House could not be brought to the millions of American radio sets. These little known, behind-the-scene transmission facilities are the life stream of radio.

As a former vice-president of the Columbia Broadcasting Company pointed out :

It is to the telephone, not to radio, that we owe the development of the equipment whereby speech and music are made available for broadcasting. More than this, it is the telephone wire, not radio, which carries programs the length and breadth of the country. John Smith, in San Francisco, listens of a Sunday afternoon to the New York Philharmonic Orchestra

playing in Carnegie Hall. For 3200 miles the telephone wire carries the program so faithfully that scarcely an overtone is lost; for perhaps fifteen miles it travels by radio to enter John Smith's house. And then he wonders at the marvels of radio!

But what about programs from overseas? Here, indeed, wireless telephony steps in, but not broadcasting in the ordinary sense. The program from London is telephoned across the Atlantic by radio, but on frequencies entirely outside of the broadcast band. Broadcasting is the child of the telephone.

And telephone engineers have not given up yet. We may confidently expect to see still more wonders come about as by-products of that uninteresting-looking little device which Alexander Graham Bell exhibited at the Philadelphia Centennial.

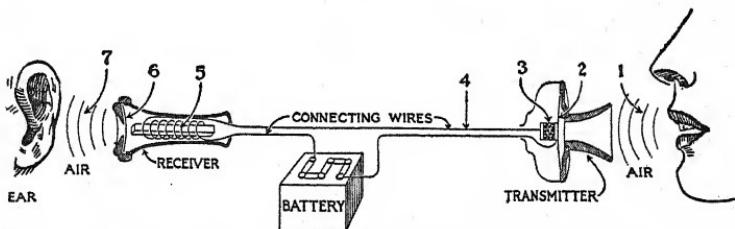


Chart showing the simplest telephone circuit. Molecules of air set in wave motion (1) by the voice of the speaker rush against the diaphragm of the transmitter (2) causing it to vibrate. This varies the closeness with which the carbon granules (3) are packed together, which in turn varies their resistance to the electrical current from the battery passing through the connecting wires (4). The variation in current thus caused varies the pull of the magnet (5) on the receiver diaphragm (6) causing it to vibrate and set the molecules of air near it into wave motion like that caused by the speaker's voice.

—Reproduced from *The Magic of Communication*,
by courtesy of the author, Mr. John Mills.

CHAPTER VIII

THE CHALLENGE OF WORLD-WIDE NETWORKS

ONCE COMMERCIAL RADIOTELEPHONY WAS STARTED, WITH the opening of the New York-London transatlantic service, it spread at an amazing pace, making voice communication possible first between the United States and the principal countries of Western Europe ; then between Berlin, London, Paris, Madrid and the Argentine capital, Buenos Aires ; between Amsterdam and Bandoeng, Java ; and between New York and Buenos Aires. It was not that there was much actual demand for these facilities from either big business or diplomatic circles, but that some European leaders had recovered sufficiently from World War I to have a reviving interest in trade expansion, and an optimistic confidence in improving international relations. As for Americans, many of them seemed to be inspired by a religious zeal for uniting all mankind.

General John J. Carty, the Chief Engineer of the American Telephone and Telegraph Company, who had directed many of this company's most remarkable achievements, prophesied enthusiastically : "Some day we will build up a world telephone system making necessary to all peoples the use of a common language, or common understanding of languages, which will join all the people of the earth into one brotherhood. We are only just beginning," he said, "to appreciate how fundamental are electrical communications in the organization of society. We are as yet

unable to appreciate how vital they are to the ultimate welfare of mankind." The press of even such faraway places as Alexandria, Egypt, and Madras, India, quoted him: "When, by the aid of science and philosophy and religion, man has prepared himself to receive the message, we can all believe there will be heard, throughout the earth, a great voice coming out of the ether, which will proclaim, 'Peace on earth, good will towards men.'"

In this day of cynicism, distrust, and nervous distraction it seems almost incredible that such words could ever have been spoken by one of the most able engineers ever associated with the telephone. Today they give one the bewildered feeling of looking at an exquisite piece of surrealism painted by Salvadore Dali. Yet when they were broadcast from seven radio stations, reaching from San Francisco to Havana, and heard, according to the estimates of leading New York newspapers, by no less than fifty million listeners throughout the United States, Cuba and parts of Canada, thousands of congratulatory telegrams and letters came pouring in, in acknowledgment of both the technical perfection of the demonstration the speaker had given, and the lofty character of his address.

One, from a retired U. S. Army Signal Corps officer, read in part:

The whole of Washington is discussing with wonder the marvelous achievement which you conducted last night. To be able to transmit the world's best thoughts and music throughout this vast area, places electrical engineering on an entirely new high level of usefulness.

The New York representative of a great London daily said, "I thought your remarks anent group conscience and

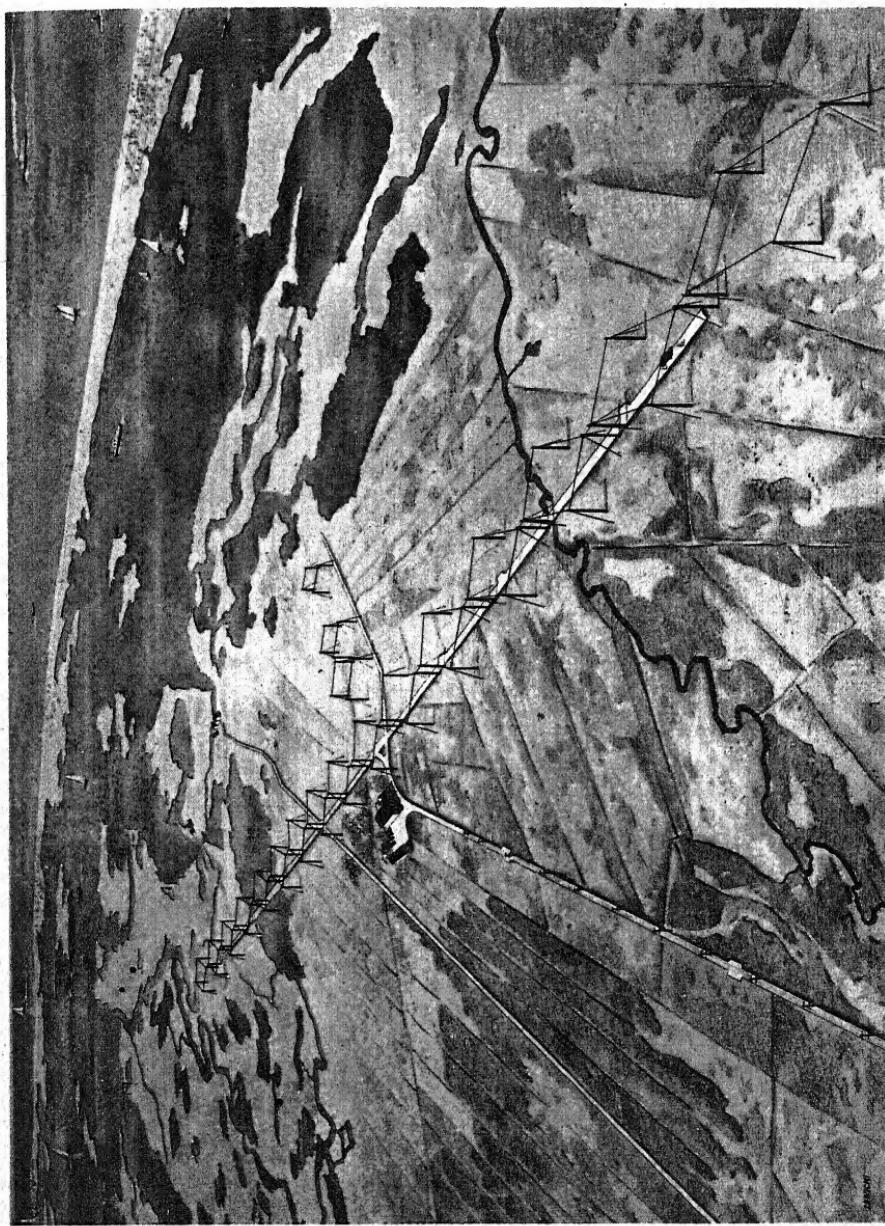
the evolution of civilization were particularly appropriate to the occasion."

A Cleveland newspaper said editorially:

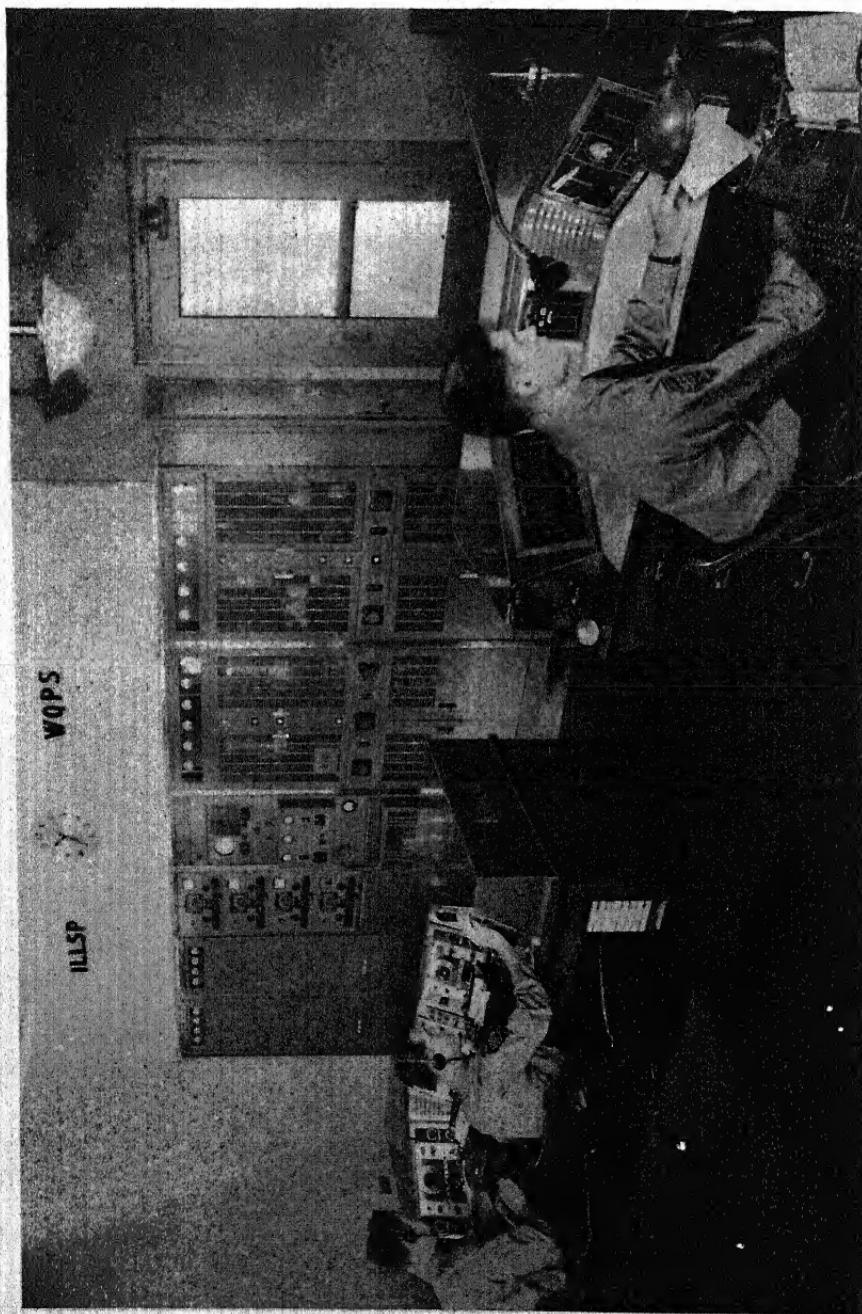
How is that for vision? . . . He must be a man who can see beyond the end of his nose. He must be one who thinks in other terms than dollars, part of the time, at least.

Under Carty's able leadership, man was well prepared with "the aid of science . . . to receive the message"; the technical obstacles to world-wide speech communication had been faced, studied and to an adequate degree overcome. Methods and equipment had been devised for magnifying a voice into a veritable thunderbolt of speech, which could be hurled across oceans with the speed of light. And though, like thunder, this mighty voice faded away as it traveled farther and farther, the spent impulse, reaching its destination with less energy than would fall on one's bare hand from the North Star on a clear night, could be built up again a billion-fold by telephone engineers, and reconverted into intelligible speech. The long radio waves which had originally served as a means of transportation had been replaced by short ones, which were much more efficient and economical to use. Methods had even been devised to compensate for cosmic and solar radiation, sun-spot activity and magnetic storms, all of which work havoc with telephone service.

As radiotelephone service expanded, objections to lack of privacy were largely overcome by the development of directional antennas and a device which "scrambled" speech. "Mary had a little lamb" for example might speed through the air as:



A. T. & T. Co.'s aerial view of the receiving station for transatlantic calls at Manahawkin, N. J.



Illinois state police radio system

Noyl hob e yllippey ylond,
Heez fludes yez yout oz smay,
Umb adjew-yahrr thop noyl yump,
Thoo ylond yez theer pee gay,

but be unscrambled again as it was put back on telephone wires. A system of electrical filters whose frequency bands changed several times a minute was the ultimate in secrecy devices. It inverted speech so thoroughly that deciphering, except by the receiver designed for the purpose, was absolutely impossible.

Some of the human obstacles to communication were also overcome. Scores of private telephone companies and government operating agencies signed agreements to establish and maintain such facilities for service in their territory, as were necessary to function satisfactorily with other parts of the network, and the demands likely to be put upon it. Many countries, whose telephone systems, social habits and economic needs differed very widely, were brought to cooperate in standardizing telephone equipment and practices, and in rendering service to each other, even though they did not share a common language or a common day and night.

Many heads of governments took part in the ceremonies connected with the addition of new countries to the network. President Coolidge on such an occasion spoke with King Alfonso of Spain, the first time in history that an American president conversed with a European monarch by telephone.

For the settlement of international telephone bills, an international unit of exchange was created, a gold franc intended to be worth about nineteen cents. Methods of charging, collecting, accounting, and dividing the revenues,

for calls going through several countries, were worked out. The quantity and quality of service went up, while the charges for it went down to about one third of the original rate.

By January 1, 1939, there were approximately two hundred direct long radiotelephone circuits connecting the principal cities of all five continents.¹ It was possible to talk from any one of almost 20,000,000 interconnected telephones in the United States to any one of more than 16,000,000 telephones in 72 foreign countries, distant territories or possessions of the United States. Not only was it possible to do this, but almost 60,000 overseas messages a year—an average of about 150 a day—were exchanged between this country and others. It is difficult to estimate the total number of international messages carried by all of the telephone circuits of the world, but it is clearly evident that this telephone service was a truly great cooperative undertaking, and that it held tremendous possibilities for good for all the people of the world. The actual value of the world-wide telephone network, however, depended upon the use which people made of it.

The last addition to the list of foreign countries within voice reach of the United States was China. Conversations marking the formal opening of this service were held in 1937. Secretary Hull, speaking to Foreign Affairs Minister Wang, recalled that the first American ship to visit China with a cargo of merchandise arrived in Canton in 1784, the voyage from New York having taken more than six months. "Today," he added, "I am exchanging greetings with you halfway around the world in approximately the same time as would be required were we talking by telephone from different points in the same city."

In reply, Dr. Wang pointed to Confucius' ideal of universal brotherhood, and remarked that scientific achievements "have gradually led human beings, whatever their race, religion and political creed to live, think and act like members of one great family."

Only two months afterwards, Sino-Japanese hostilities broke out again and this service to China was disrupted. Two years elapsed; two years in which the number of international telephone calls were the highest they had ever been; two years in which international distrust and fear were constantly increasing.

Then, as *American White Paper*² tells it:

At twenty minutes to three on the morning of September 1, 1939, a buzzer sounded at the White House telephone switchboard. The sleepy night operator plugged in her line. A voice came, "Paris calling," and then another voice, strangely sharp and harsh, "May I speak to the President?" . . . The operator sounded the bell in the President's bedroom, and the President roused himself quickly and picked up the telephone by his bed.

"Who is it?"

"This is Bill Bullitt, Mr. President."

"Yes, Bill."

"Tony Biddle has just got through from Warsaw, Mr. President. Several German divisions are deep in Polish territory, and fighting is heavy. Tony said there were reports of bombers over the city. Then he was cut off. He'd tried to get you for half an hour before he called me."

"Well, Bill, it's come at last. God help us all."

Both President Roosevelt and Secretary Hull wanted to talk to Ambassadors Bullitt in Paris, Kennedy in London and Biddle in Warsaw on that day, as well as to the American chargé d'affaires in Berlin, but they were kept waiting

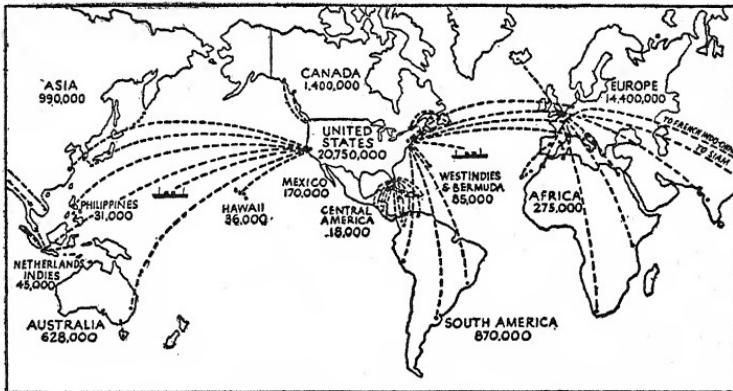
for connections which were always just on the point of being made; the "diplomatic static" was very troublesome. Operators at the London end of our busiest overseas circuit reported to their co-workers at the New York switchboards that they were having to discontinue service until further notice. Four great European nations had plunged into war, and rendered a large part of the world-wide telephone network practically useless.

Over five thousand reporters and correspondents of the American press "were poised and ready" . . . but the warring governments made it as difficult for the neutral world to know the truth as in the days of Napoleon I, the Rothschilds and Andrew Jackson.³ London refused to handle any except official calls, and service was either restricted or suspended wherever British and French influence prevailed. Telephone service to belligerents' ships at sea was also practically wiped out.

Alas, the world-wide telephone network, created to help bind people together, increase their understanding and strengthen them with good will! Had it utterly failed? Was all the inventive genius, the engineering skill and the cooperative enterprise which had gone toward perfecting it, to count for nothing? Not while American telephone engineers still clung to their ideal of universal telephone service! They promptly arranged for transatlantic facilities in Amsterdam, to take the place of those in London and Paris no longer available to the public. Rome and Berlin were also provided with direct radiotelephone circuits from New York. Then the Amsterdam facilities had to be given up, but new ones were arranged for in Berne, Switzerland, and Madrid.

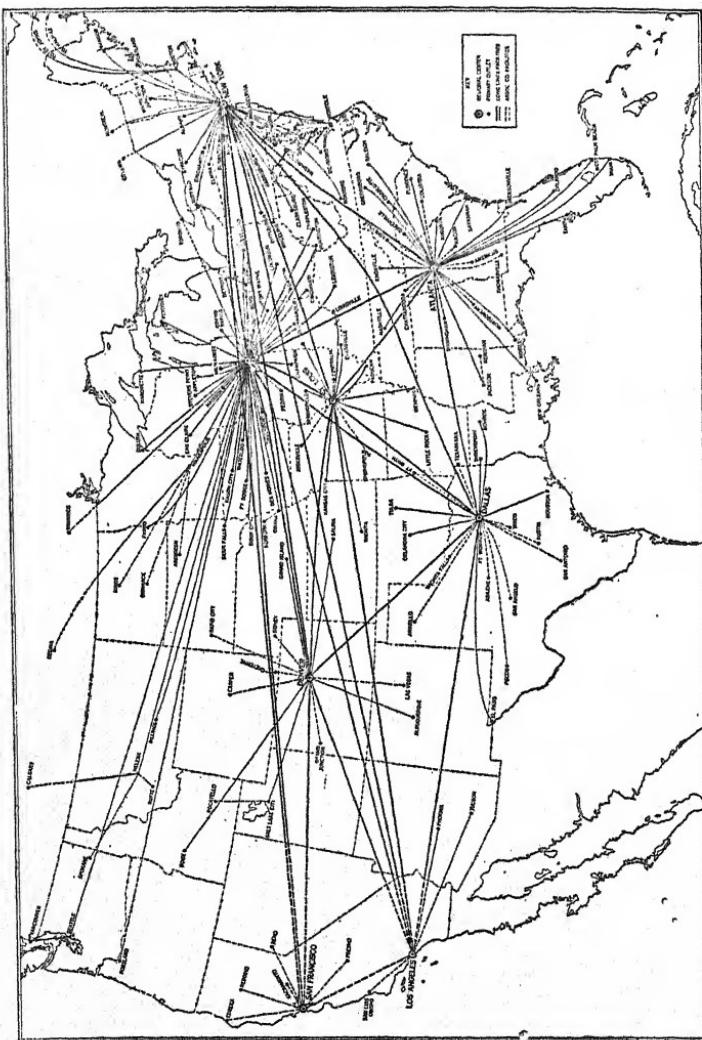
There is nothing the matter with the world-wide tele-

phone network; it is standing up magnificently. The trouble is with men. If only they would look at it with eyes unblinded by greed and fear, they might see in it a challenge to the making of a better world, a world that, like the telephone, transcends national boundaries, and banishes isolation, a world that would give to people everywhere a heartening sense of convenience and security.



Overseas Telephone Connections of the Bell System

LONG LINES NETWORK



NOTES

CHAPTER I

1. *Philipp Reis: Inventor of the Telephone*, by Sylvanus P. Thompson, London, E. & F. N. Spon, 1883, pp. 14, 46. Though the German Patent Office, some twenty years later, after careful search, decided that Reis' instrument was not a speaking telephone, German people still like to think that Bell's instrument was simply an improvement of Reis' invention.

2. After further experimentation, Berliner applied for a patent for a carbon button transmitter in June, 1877. Though Berliner's patent was not granted until fourteen years later, he was hired by the Bell Telephone Company and made chief inspector of instruments, in 1878. He became a prolific inventor.

3. For further details see *American Tel. and Tel.* by Horace Coon, Longmans, Green and Co., New York, 1939, Chapter IV, "Who invented the Telephone?"

For three generations Bells had been professors of speech in Edinburgh, and London, and, through his father, Alexander Graham Bell had had the opportunity of meeting several eminent scientists. As a boy, "Alec" and his brother built a skull and larynx, which they worked with a bellows. It cried "Mama" so realistically that a neighbor inquired, "Whose child is that?"

In his teens, because he had lost two brothers with tuberculosis in Scotland, Bell was brought by his parents to Canada. For a while, he had a good time with a tribe of Mohawk Indians, teaching them to speak English by his father's method. When he was twenty-four, he was called to Boston by the Board of Education, to teach deaf students there. It was by his teaching that he partly supported himself while carrying on his experiments with the "harmonic telegraph" and telephone.

After inventing the telephone, Bell became interested in reproducing speech by means of light waves reflected from a mirror onto a selenium cell — the first sort of wireless telephone. It was called the photophone. Bell read a paper describing it to the American Association for the Advancement of Science in Boston, in 1879. In 1880, he was called to Europe by the French Government to be awarded the Volta Prize and returned to continue his experiments in producing sound by means of light.

All during the summer of 1881, after President Garfield had been shot,

Bell worked in Washington on a telephone probe for locating the bullet which remained in the President's abdomen. Though this surgical sounding device was completed too late to save Garfield's life, several years later, because of it, Bell was awarded an honorary M. D. degree by Heidelberg University.

In November, 1882, the Supreme Court of the District of Columbia admitted Bell to U. S. citizenship. From then until almost 1900, though taking no active part in the telephone business, he was on call to defend his patents for the Bell telephone companies in the almost twenty years of litigation to which they were subjected by competitors and rival inventors.

Even before the turn of the century, both Bell and his wife were also interested in flying machines; S. P. Langley, Glenn H. Curtiss and Casey Baldwin, all were associated with them. When World War I came, Bell began experiments to develop submarine chasers.

In 1915, Bell talked from New York to his old co-worker, Watson, in San Francisco at the opening of the coast-to-coast telephone service—"Watson, come here, I want you," he called. And Watson, who had rushed down the little attic passage forty years before to find his employer wiping battery acid off his trousers, replied, "It would take me a week to come, instead of a minute."

Revisiting his native Edinburgh in 1920, Bell was honored with the keys of the city. In 1922, he passed away at the age of seventy-five. He was buried at sunset, August 4, on the summit of a hill on his own estate near Baddeck, Nova Scotia. As tribute during the simple funeral ceremony, telephone service was suspended for one minute throughout the United States. See *Alexander Graham Bell, The Man Who Contracted Space*, Catherine Mackenzie, Houghton Mifflin Co., Boston, 1928.

4. Through his teaching Bell became acquainted with Mr. Thomas Sanders and Mr. Gardiner Greene Hubbard, each of whom had a deaf child. Mr. Sanders was a business man; Mr. Hubbard, a promoter and lawyer, well known in Washington, D. C. Later he became a regent of the Smithsonian Institution, and founder and first president of the National Geographic Society, as well as Bell's father-in-law.

5. Bell's student was Shuji Isawa, his friends Shinichiro Kurino and Kentaro Kaneko. Isawa upon his return to Japan became in succession, president of a music college, principal of a school for the deaf and dumb; and founder of an institution for stammerers. Concerning Kurino, in "Who's Who in Japan" is the note: "well known as the father of the telephone administration in Japan."

6. Thomas Watson (1854-1934) when he first met Bell was a twenty-year-old mechanician in Charles Williams' Telegraph Instrument shop. He had had no scientific education; in fact there was not a course in electrical engineering to be had in those days, but he had a natural gift for solving technical problems. Bell persuaded him to give up working for Mr. Williams on telegraph and fire alarm devices and to concentrate

on the problems of the telephone. In September, 1876, the "Bell Patent Association" hired Watson as a mechanic for \$3.00 a day and one-tenth interest in all the patents, to make commercially practicable telephones. From the time of Bell's sailing for Europe, in 1877, until his own resignation and departure for Europe, in 1881, Watson carried the burden of the necessary research work and was in charge of the manufacture of telephone instruments. His autobiography *Exploring Life* was published in New York, in 1926.

7. A model in miniature of a telephone demonstration given in the gentlemen's parlor of a New York hotel, may be seen in the Museum of the City of New York. Among other important persons present at this demonstration was President Barnard of Columbia University. Another slightly later demonstration in New York, in which visitors were allowed to participate was attended by J. P. Morgan, William Cullen Bryant, Samuel Morse, Wendell Phillips.

8. Lawrence, Mass. *Daily American* May 29, 1877.

9. *The Telephone, the Microphone and the Phonograph*, by Count Du Moncel, Harper & Brothers, New York, 1879.

10. *In One Man's Life*, by Albert Bigelow Paine, Harper & Brothers, New York, 1921, p. 113.

11. This victory over the Western Union was achieved by the very able financiers and lawyers Forbes, Fish and Storrow, together with Vail. The obscure speech teacher, Bell, was downright lucky in having made the connections he did. His patent, which the courts sustained many times later, came to be known as the most valuable one in the whole history of the U. S. Patent Office.

CHAPTER II

1. Quoted from *American Telegraph Magazine* by Alvin F. Harlow in *Old Wires and New Waves*, D. Appleton-Century Company, N. Y., 1936, p. 77.

2. Alfred Ely Beach, editor of the *Scientific American* had had a tunnel nine feet in diameter constructed for a distance of one block under lower Broadway.

3. On the multiple switchboard, each subscriber line is duplicated on every section of the board. One equipped to service 6000 subscriber lines and consisting of 20 sections, for example, has 20 times 6000 or 120,000 points of connection, so that the operator at each section, in answer to a call from any of the subscribers whose lines are assigned to her, can connect that subscriber line with any one of the 5999 other subscriber lines terminating at the switchboard. The largest of this type board has more than two million tiny soldered parts, 15,000 electrical signal lights and more than enough wire to span the continent, 4000 miles of it.

4. Mac Meal, Harry B., *The Story of Independent Telephony*, Indiana Pioneer Telephone Association, 1934, p. 32.

5. In the United States today, more people use more public telephones more often than in any other country in the world, and the telephone booth has been made to conform to all sorts of environments.

6. See *Inside the Department of State* by Bertram Hulen, McGraw-Hill Book Co., N. Y., 1939 (Chapter on Communications). He also says (p. 157) "When typewriters were introduced to its offices, veterans of the Department of State complained that it meant the passing of classical diplomacy, and the days when diplomatic notes were written in elegantly formed letters by longhand. The ability to write a good hand was no longer one of the first requirements for employment in the Department."

7. An interesting installation of this sort, which probably many natives and visitors to Detroit have unknowingly walked over, is more than a thousand feet below Fort Street and Oakwood Boulevard, in the world's second largest salt mine. A switchboard and several phones were installed down in the mine, and two trunk lines connected them with headquarters in Scranton, and sales offices in Chicago.

8. In 1909, Vail bought control of Western Union for \$30,000,000. Even at that time, it is said, as President of the A. T. and T., he was practically unknown in many places and was shown no special attention, but, as president of the Western Union, he made bellboys all over the country break into a sweat. See *Fortune*, November, 1935, p. 91.

9. Automatic exchanges were also exhibited for the first time at this exposition by both the Bell and the Strowger Company.

10. The Panama Canal cost the United States approximately \$367,-000,000. During the nine or ten years it was being built, the Bell System is reported to have spent on construction engineering alone well over \$600,000,000.

11. The growth of suburban communities is just one of these changes. Without the telephone, suburban life certainly would not be as popular or as highly developed as it is today. Not only does the phone make it possible for the suburbanite to shop and buy in the city, and keep in touch with city activities, but it also facilitates local social activity, and organized community enterprise.

CHAPTER III

1. The Edison Telephone Company of London opened a commercial telephone system for the use of the British public in September 1879, and for a time employed no less a personage than George Bernard Shaw as "waylease manager." About this experience G. B. S. wrote, (*The Irrational Knot*, Preface ix-x, London, Archibald Constable and Co. Ltd., 1905.) "My last attempt to earn an honest living was in 1879, when a company was formed in London to exploit an ingenious invention by

Mr. Thomas Alva Edison — a much too ingenious invention as it proved, being nothing less than a telephone of such stentorian efficiency that it bellowed your most private communications all over the house, instead of whispering them with some sort of discretion. This was not what the British stockbroker wanted, so the company was soon merged in the National (United) Telephone Company after making a place for itself in the history of literature, quite unintentionally, by providing me with a job. Whilst the Edison Telephone Company lasted, it crowded the basement of a huge pile of offices in Queen Victoria Street with American artificers . . . They adored Mr. Edison, as the greatest man of all time, in every possible department of science, art and philosophy, and execrated Mr. Graham Bell, the inventor of the rival telephone, as his satanic adversary ; but each of them had (or pretended to have) on the brink of completion, an improvement of the telephone, usually a new transmitter."

2. Early in the development of the telephone business in the United States, arrangements were made to have the Western Electric Company manufacture all the telephone apparatus for the Bell System. This arrangement still holds ; the advantage of complete standardization is shown clearly whenever some disaster destroys telephone plants in wide areas.

3. For statistics on the telephone abroad, see *Telephone and Telegraph Statistics of the World*, published annually by the American Telephone and Telegraph Company.

4. In this connection an amusing story is told of a respectable-looking visitor to the Wembley Exposition held in England in 1925. Noticing a row of desk stand type telephones on a table, he leaned down to the nearest one, fixed an eye at the transmitter mouthpiece and gazed long and earnestly. The view evidently failing to come up to his expectations, he tried another and another, and at last walked regretfully away.

5. For the part of the U. S. Signal Corps and telephone operators in World War I, see *Circuits of Victory* by A. Lincoln Lavine, N. Y., 1921.

6. Though South American governments did not send troops to World War I, thousands of immigrants especially Italians from Argentina returned to Europe.

7. The International Telephone and Telegraph Corporation was organized in 1921 by Colonel Sosthenes Behn, United States citizen and sugar planter born in the Virgin Islands of French and Danish parents. Beginning in 1906, with a local island telephone system, which came to him as security for a loan, he later bought a Mexican telephone company and ran a line up to the United States border, arranged with the A. T. and T. for a cable between Havana, Cuba, and Key West, Florida, and contracted to run the telephone service for Spain. The I. T. and T. now controls the telephone business in Rumania, Cuba, Puerto Rico, Peru, 90% of the telephones in Northern Argentina and Chile, Southern Brazil, Uruguay, half of Mexico, and Shanghai. With its associated company,

International Standard Electric, it also controls factories for cable, telephone apparatus and equipment and home radio sets in France, England, Belgium and Australia. Patents developed by I. T. and T. subsidiaries abroad, and there have been many, are also available to the Bell System in the United States. The Spanish telephone system, when installed in 1925 was largely automatic in the large cities. During the 1936-39 war in Spain, both sides were so careful of telephone facilities that I. T. and T. losses were surprisingly much less than anticipated.

8. The wild scramble of European nations to grab up shares of Africa began in 1883. Soon after that, telephones were introduced into Natal, Transvaal and Orange Free State. By order of King Leopold II of Belgium, one strand of copper wire was strung through 750 miles of the Congo River jungle. What with the tropical heat and diseases, white ants, wild elephants, monkeys and savages, this was noted as one of the most adventurous pieces of work in early telephone history.

9. The small installation of the British Shanghai Mutual Telephone Company included all of the telephones in China before the Boxer Uprising in 1900. Then troops of the Western Powers marching up from Tientsin, to the relief of their besieged nationals in the legation quarter of Peking, stretched a telephone line as they went, and this was later left for the Chinese, who bought more equipment and kept it going as the basis of a larger system. In 1939-40, large numbers of Chinese and Japanese moving into Shanghai from other parts of China, realizing quickly the protection and convenience which it afforded, caused a sudden boom for the telephone.

10. The so-called "French phone" was really invented by an American, Robert G. Brown. To avoid the inconvenience of holding a receiver in one hand and a transmitter in the other, he mounted both on a curved iron bar, which also served as part of the receiver. Brown went to France, in 1879, as chief engineer for the Société Générale des Téléphones and installed a central office system in several cities. In the first exchange opened in Paris, his handsets were used by operators. They were thought unsuitable for development in the United States at that time because sounds played back and forth very badly between transmitter and receiver and interfered with conversation. The transmitter was also thought to be too delicate an instrument to operate satisfactorily when banged down on a hook repeatedly.

11. Throughout the tropics, telephone linemen have to meet peculiar problems set for them by animals, birds and insects. Monkeys throw coconuts which break the wires; giraffes have been known to cause trouble with their long necks; birds often disrupt service by building their nests or dropping twigs and threads across two wires. In Australia, bunches of loose wires are put up on poles for the magpies, to keep them from taking wires essential to service, for nest building material. Rats, also, especially in China and Manila, work havoc with telephone apparatus; and the cats kept to frighten away the rats refuse to go out

of doors as soon as the rainy season sets in. Termites and other insects are dreaded enemies of telephone poles.

12. Along about 1901, this same practice was introduced in Chicago, San Francisco and Boston, partly because people, on whose premises pay phones were installed, got tired of making good for all the price tags, iron washers and miscellaneous discs which the telephone companies' collectors found in the boxes. In New York City, instead of introducing slug coin boxes, the telephone company bought new machinery for the city's largest suppliers of round tin-edged price tags, so that these would no longer be made the same size as nickels, dimes and quarters.

CHAPTER IV

1. *American Tel. and Tel., The Story of a Great Monopoly*, by Horace Coon, Longmans Green and Co., N. Y., 1939, p. 2.

2. The largest manufacturers are the Western Electric Company, an integral part of the Bell System, with three factories: at Hawthorne, Illinois, just outside of Chicago; at Point Breeze, Maryland, near Baltimore and Washington; and at Kearny, New Jersey, within a few miles of New York City. At a small plant called Queensboro in Brooklyn, New York, Bell System telephone booths are made. Other large and long established manufacturers of telephone apparatus and equipment in the United States are the Automatic Electric Company and Kellogg Switchboard and Supply Company of Chicago, the Stromberg, Carlson Company of Rochester, New York, and the North Electric Company at Galion, Ohio. Cable, wire, strand, conduit, timber products and hardware are also supplied by specialized producers.

The Western Electric Company has 29 distributing houses located at strategic points for rushing installations and repairs in congested areas. The value of maintaining these is dramatically demonstrated whenever unexpected and widespread damage is caused to telephone lines.

3. Instead of being wrapped with paper strips to insulate them, more and more wires are being drawn through a sort of wood pulp soup which forms a uniform coating over them and is baked on.

4. Twelve bills a year to each of about fifteen million subscribers (there are, of course, fewer subscribers than telephones) makes a total of about a hundred and eighty million bills; if all could be sent at two cents each, the postage stamps alone for these would cost \$3,600,000.

5. One of these, who had bought rather heavily of American Telephone through his Paris broker, was an elderly Mohammedan gentleman in Qairwan, Tunisia, who according to local custom, always had his guests' feet washed by a servant and covered with white silk sandals whenever they entered his home. In discussing his telephone stock he said, "So far it has turned out very well; I only fear that someday something better than the telephone may be invented."

6. About 250 financial houses and 750 others have leased private wire service; over 200 of these are operated between New York and Philadelphia.

7. Secretary Stimson began the first appreciable use of the transatlantic telephone by the Department of State. In 1931, he was holding several conversations a week with London and Paris concerning his diplomacy with respect to Manchuria. He and President Hoover telephoned so frequently to United States officials and the heads of other governments abroad that various newspaper editorials noted it as a new departure in diplomacy.

They were criticized for this because the telephone leaves no permanent records but Secretary Stimson met the objection by having several members of his staff present during his overseas conversations to make observations and notes as desired.

Though it became regular practice to make stenographic reports of all overseas conversations, Secretary Hull had another objection to this type of communication. He felt that it tends to encourage snap decisions, when it would be better for officials to take second thought and proceed with less haste. In general, he used the radiotelephone only, as from the Pan-American Conference in Lima, Peru, to obtain current information and factual reports. The telegraph is thought to provide sufficient speed for most situations and it has the advantage of the protection of secret diplomatic code. Even though the voice is scrambled in its flight through the ether, the scrambling does not take place on land lines leading to and from the wireless station, and in Europe the privacy of these is far from inviolate. There is a story that embassy spokesmen, as a joke on eavesdroppers, often say "go slow so they can be sure to get it." Where wire facilities in which tapping can be guarded against are available, however, as between Washington and the Legation in Ottawa or the Embassies in Mexico City and Havana, a great deal of business is transacted by telephone. See p. 200, n. 6.

8. A pamphlet *Taming our Forests* by Martha Bensley Bruere, published by the U. S. Department of Agriculture, Forest Service, in August, 1939, gives fuller details in very attractive and readable form.

9. On the average more than a quarter of a million calls are made from public telephones every hour. Because of the large number of public phones available, however, this means only one call every two hours per phone. Generally the public phones in the largest cities are the ones kept busiest; those on Manhattan Island in New York City hold the record, because of the enormous daily nonresident population, including hundreds of thousands of visitors as well as commuters, whose continuous making and changing of plans help to run up a total of over a million and a half calls a day.

10. The first coastal and harbor radiotelephone shore station was opened for commercial business at Marshfield, Massachusetts, on July 1, 1934. This station, which serves Boston harbor and coastal waters in

the vicinity, is now one of a chain of stations on the Atlantic and Pacific Coasts and the Great Lakes.

11. When a boat is first equipped with a radiotelephone set, the owner ordinarily informs the telephone company, so that the necessary information for handling calls can be posted on the company's records and an account established. It is also necessary to have a knowledge of the laws and regulations relating to this type of equipment, so as to secure a third class telephone operator's license as required by the Federal Communications Commission. This Commission also licenses each boat as a ship radio station and assigns it a call letter.

CHAPTER V

1. In Germany, the first telephone operators were recruited from the ranks of superannuated postmen but, as time went on, girls took their places. Since boys of suitable age were not available because of compulsory military training, girls were employed from the beginning, in Paris. These French operators were subject to civil service rules, were forbidden to marry without permission of the Postmaster General and on no account might they marry "a mayor, a policeman, a cashier or a foreigner, lest they betray the secrets of the switchboard."

2. The Sabbath problem was much greater in Turkey than in the United States; for Constantinople had three sabbaths every week, Friday for the Mohammedans, Saturday for the Jews and Sunday for the Christians, and each denomination was fairly strict in its observance.

3. The pioneers who went after operating concessions abroad also had some interesting establishments. The quarters which were rented for a telephone exchange in Odessa, Russia, consisted of "four rooms on the first floor with two varnished brick ovens, one room and kitchen on third story, one place in corner of yard, and roof over house" (with the right to build a wire tower on it). Part of the lease for it read "Mr. Culbertson is obliged to take the necessary care against fire, to keep the necessary cleanliness, order and principally tranquility. He must have the staircase washed with the other inhabitants of the house. He is not to keep dogs and domestic birds, enter with candles into the fuel place, or alight the samovar in the corridor."

4. Back in the early 'eighties, it is recorded that the boy operators in the Fulton Street exchange in New York City wrote a letter to their manager demanding an increase of five dollars to bring their monthly earnings up to twenty-five dollars. The manager called in all the boys one by one, fired the first one and told the others he thought they had nothing to complain of. They demanded the re-employment of their comrade, and when their demand was not met, walked out of their office and up to the Beaver Street and the City Hall exchanges to get the five boys from these two exchanges to go on strike with them. Newspaper

reporters learned of the uprising and gave it some publicity; several subscribers threatened suit if their telephone service were interrupted; the manager notified the boys that he would meet their demands and they returned to their switchboards — all in the lapse of less than twenty-four hours. Already suspension of telephone service seemed a serious matter. Today, local as well as federal government agencies consider willful interruption of telephone service a very serious offense.

5. In some places in Cuba, it is customary for widows with grown daughters to be given the privilege of having exchanges in their homes; the girls may thus act as operators and earn a salary without working in public; and the telephone company is saved the expense of renting special buildings.

6. In Japan, the newest operators are assigned to the boards with the highest numbers because high numbers, being harder to remember, do not bring such a good price as low numbers and, therefore, are not given such experienced service.

7. *People at Work*, by Frances Perkins, The John Day Company: New York, 1934, p. 209.

8. A rather interesting sidelight on this point for the edification of subscribers, is given by the following excerpt from a Danish pamphlet, *The Development of Telephonic Communication in Copenhagen 1881-1931*:

"Great attention has been paid to the quality of operator service, it is endeavored by thorough and careful attention to give fullest possible satisfaction to each individual subscriber. Dissatisfied and difficult subscribers are connected to special positions where they are treated with the greatest consideration by selected operators of imperturbable equanimity and of pleasing and obliging personality. Experience has shown that after being served for some time at these positions, the subscribers become more kindly disposed, and their lines can be reconnected to ordinary positions."

9. The maximum charge for such a call on a daytime, station-to-station, three-minute basis as of May 1, 1940, was five dollars; night and week-end rates for the same sort of call were four dollars.

CHAPTER VI

1. The Quebec directory is bilingual, having French and English instructions, etc. in parallel columns. Several busy port cities throughout the world follow a similar practice. Shanghai has two separate directories, one in Chinese and one in English. There is nothing like a Chinese or Japanese telephone directory for making one appreciate a phonetic script, such as we have, which permits alphabetical arrangement. It is almost impossible to look up a Chinese name if one knows only

the way it sounds, for there may be a dozen or more different Chinese symbols, or characters, for that same sound. Even assuming that one knows how the name is written, the task is not simple. First, you must count the number of brush strokes which compose the symbol, then you must consult a reference list of characters having the same number of strokes, and there may be scores of them; from this you will learn the number of the page in the directory on which names written with this character begin, then turning to this page, beginning from the back of the book, one is confronted with several columns of the same name, distinguished only by address.

The Japanese use the same symbols as the Chinese do; they borrowed them from the Chinese more than a thousand years ago, before they had any script of their own but, for convenience, the Japanese developed a sort of phonetic shorthand, which has forty-nine different symbols, pronounced: ä, ē, öö, å, ö, kå, kå, kë, koo, kå, kô, sâ, shë, sôö, etc., and arranged in a definite order. Telephone directories are also arranged according to this order. The trouble here is that even though one knows how a name is written, one cannot find it in a directory without knowing, also, how it is pronounced, for though the arrangement is according to the Japanese phonetic script, the type symbol used to represent the name is the Chinese one. The manager of the exchange in Chinatown, San Francisco, says that they get around this difficulty there by listing their 2100 subscribers in order of address, rather than name, and requiring all operators to learn all subscribers' names and addresses by heart. Even Chinese and Japanese themselves frequently give up and ask for information. See *The Pageant of Japanese History*, Marion May Dilts, Longmans, Green and Company, New York, 1938, pp. 114-7.

2. London has its "Buff Book."

3. Skimming through the classified telephone directory of a strange city has, also, often proved to be a very enlightening and valuable practice for travelers.

4. In New York City, the local directories at telephone booths in many public places are used so much that they have to be replaced about every two weeks; those in a drug store just above Times Square, it is said, are replaced every four days.

5. In Japan, numbers containing the digit four, which is pronounced shi—the same as the word for death—are thought to be unlucky—42 and 49 are especially so—often, they are reserved for prisons and institutions for the insane.

6. A comparison of the most common names in foreign directories is also rather interesting. The telephone directory of Stockholm, Sweden, for instance, specializes in the following name with ten different spellings:

Ohlsen, Ohlson, Ohlssen, Ohlsson, Ohlzon, Olšen, Olson, Olszen, Olsson, Olzon.

While the 1940 London telephone directory had twenty-two pages containing 5057 listings of Smith, the Paris one had only 18 with this surname. The most common name in the Paris directory for the same year was Levy; almost 700 of them there were. Paris also had 38 Grand Hotels ranging from Grand Hotel Alouy to Grand Hotel de L'Univers. The 1939 Tokyo directory had 1739 Suzukis and 1143 Tanakas. Moscow's most common name, judging from its telephone directory, is Ivanoff.

Nearly 2500 Müllers are listed in the Berlin directory. Without middle names or initials to differentiate them, there are 24 Müllers named Adolf; 27, Albert; 71, Fritz; 60, Herman; 72, Karl; 71, Max; 83, Otto; and 95 Paul Müller listings! In the Shanghai directory similarly there are columns and columns of "Chang, residence of," differentiated only by address; many Chinese feel that it is healthier not to be too readily located by persons who are not familiar with their address, and also many relatives of the same name usually live under the same roof.

German directories also contain some amazingly long names of subscribers, such as, for example: Landeslieferungsgenossenschaft d. Kürschner- u. Mützenmacherhandwerks f. Berlin Brandenburg u. Grenzmark eGmbH; and Krankenhaus Knesebeck-Kinderklinik u. Heim d. Deutschen Roten Kreuzes Vaterl. Frauenverein Provinzialverein Berlin eV.

CHAPTER VII

1. Up until 1924, when it was separately incorporated, this organization was a part of the Western Electric Company, the manufacturing, purchasing and distributing unit of the Bell System.

2. Dr. Davisson's Nobel lecture, "The Discovery of Electron Waves," delivered in Stockholm is available in *Les Prix Nobel* series. It is a beautiful piece of scientific literature, rewarding to read, for the picture of the scientist which it gives.

3. City, state and federal detective agencies frequently call upon Dr. Lucas and his microscope for assistance in analyzing material clues and evidence in their investigations of crime. Detectives are also familiar with Dr. Lucas' method of making it possible to study fingerprints, not otherwise visible, on textiles and papers.

4. The development of permalloy, previously mentioned in this chapter, made possible the construction of a receiver so small that it can be attached to an earpiece fitted into the opening of the ear canal.

5. Its prodigal use of the frequencies has been one of the influences hindering the development of television; it requires a band of at least a million cycles wide for satisfactory operation. Ordinary telephone lines are not well adapted to handle television. Though they have been used for the purpose in the Madison Square and theatrical district of

New York City, the power loss is tremendous, and they could not be used for carrying television programs over appreciable distances. Coaxial cables at the moment seem to be the solution to this particular problem of telecasting, but they will be expensive to provide on a large scale.

6. Originally developed by the Morkrum Company of Chicago, the printing telegraph later came to be known as the teletype or teletypewriter, and the company which manufactured it as The Teletype Corporation. In 1930, this company was taken over by the Western Electric Company. While anyone may still buy teletypewriters and connect them up for private operation, they offer a wider range of usefulness if connected with the nation-wide Bell System TWX service.

7. Not, however, until messages were sent by this method to the fleet, during World War I, was the word "broadcasting" coined. Bell himself had made an attempt at transmitting speech without wires back in the 'eighties. Because it sent speech waves over reflected beams of light he called his device a "photophone" but it was soon rechristened "radio-phone" and this, it is said, was the earliest use of the word "radio" in the communication sense.

8. For everyday telephony, circuits which will transmit a frequency range of somewhat more than three octaves, starting with middle C, give a high degree of intelligibility so that ideas can be easily and accurately interchanged. Circuits for entertainment purposes, however, require that a range of frequencies more than twice as wide as this be transmitted. The higher frequencies transmitted over these circuits add to the "brilliancy" of music; the lower frequencies give "body" to the reproduction. Transmitting these higher and lower frequencies, in other words, reproduces the programs much more naturally, so that nice distinctions between sounds of various musical instruments are preserved.

Circuits used for radio program transmission must also be so designed as to take care of a considerable variation in volume or loudness. In an ordinary telephone conversation, the range of variation in volume is relatively small.

9. In drawing the layout for the first two N.B.C. networks years ago, telephone engineers used a blue pencil for one, and a red pencil for the other, and this was the beginning of a thoroughgoing system. There are, today, besides the red and blue networks which we hear mentioned most, purple, gold, amber, slate, bronze, peach, maroon, green, brown, navy, black, ebony, white, gray, russet, salmon, yellow, rose and violet ones. Six more shades, azure, crimson, orange, scarlet, tan and silver await the growth of new networks. The technicians in charge of monitoring the programs and safeguarding the high quality transmission of them day and night, are guided not only by the familiar arrangement of jacks and plugs associated with each network, but also by the definite colors of each chain.

10. "Broadcasting: a New Industry," *Harvard Alumni Bulletin*, December 18, 1930.

CHAPTER VIII

1. The most important of these connected :
New York with London, Paris, Bermuda, Rio de Janeiro, Lima and Buenos Aires.
Miami with Central America, Colombia, Venezuela, and the West Indies.
San Francisco with Hawaii, Japan, the Philippines, Netherlands, India and Australia.
Paris with Cairo, Algiers, Morocco and French Indo-China.
London with Australia, Tokyo, Bombay, Capetown, Cairo and Montreal.
Rome with several South American capitals and large cities in Africa.
Berlin with Bangkok, Tokyo and Manila.
Moscow with Paris, Tashkent and Tiflis.
Brussels with Leopoldville in the Belgian Congo.
Tokyo with Buenos Aires and Santiago, Formosa, Manchukuo, Shanghai, Thailand, Manila and Honolulu.
2. By Joseph Alsop and Robert Kintner, Simon and Schuster, N. Y., 1940.
 3. "Fortune's History of the War of 1939," *Fortune*, November, 1939, pp. 90-96.

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